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THE TRANSATLANTIC RECORD has again been broken by the Hamburg-American Line steamer "Deutschland," on her eastward trip from New York to Plymouth, England. The time from Sandy Hook to Lizard Head was 5 days, 6 hours and 5 minutes; which was an average speed of 23.36 knots per hour. The daily runs were 507, 540, 549, 545 and 306 knots. The North-German Lloyd Line steamer, "Kaiser Wilhelm der Grosse," which sailed the same day as the "Deutschland," made the trip between Sandy Hook and Lizard Head in 5 days, 11 hours and 32 minutes.

THE MONITOR "WYOMING" was launched at the yards of the Union Iron Works, San Francisco, Cal., on Sept. 8. Her dimensions are: Length on load-water line, 225 ft.; extreme breadth, 50 ft.; mean draft, 12 ft. 5 ins.; displacement, about 2,700 tons. The hull is protected by a side armor belt ranging from 11 to 5 ins. in thickness. The turret is of the balanced type, its armor being 9 ins. thick. A conning-tower with 7½-in. armor and a single military mast will also appear above the deck. The vessel is to make 12 knots an hour. Her main battery will consist of two 12-in. breechloading rifles and four 4-in. rapid-fire rifles. In the secondary battery will be three 6-pdr. rapid-fire guns and four 1-pdr. automatic rifles.

THE DESTRUCTIVE POWER OF THE GUNS of a modern battleship was demonstrated recently in an experiment made by the British Admiralty. The old battleship "Belleisle" was fired upon for nine minutes by the battleship "Majestic" at a range of 1,300 to 1,700 yards and while steaming at a speed of 6 knots per hr. The "Belleisle" is of 5,000 tons displacement and has iron armor disposed as follows: belt, 12 to 6 ins.; battery, 10 to 8 ins.; redoubt below battery, 9 to 8 ins.; conning tower, 12 ins. The "Majestic" carries 12-in., 6-in. and 3-in. guns, all of which were fired, the 12-in. guns using both common shell and armor-piercing shot. About 38 to 40% of the shots fired were effective and some of the hits were very destructive, the target being promptly sunk. The London "Engineer" sums up the conclusions to be drawn from the experiment as follows:

Save in absolutely still water, a complete water-line belt has no value whatever.
It is easier to hit a ship end on than when she presents her broadside.
The battle of the future will be won by whoever gets in the first hit, or first one minute's hitting.
The theorists have been shown to be correct in nearly all their theories.
Danger of fire from wood work is quite a minor affair, and if the main hose lines are protected and the ship well doused beforehand, no serious danger is to be apprehended from fire.
The 12-in. gun is the gun of the future.

THE GREAT KRUPP FIRM ranks among the largest producers of iron and steel in the world, being exceeded only by the large American companies. A recent report of the Essen Chamber of Commerce gives a list of the industries operated by the Krupp firm, and it is quoted from as follows by U. S. Consul Guenther, of Frankfort, in a recent report:

The cast-steel works of Frederick Krupp comprise the following: Cast-steel works, at Essen; Krupp steel works, formerly F. Asthöwer & Co., at Annen, in Westphalia; the Gruson works, at Buckau, near Magdeburg; four blast furnaces at Duisburg, Neuwied, Engers, and Rheinhausen (this latter consists of three furnaces with a capacity for each of 230 tons per 24 hours); a foundry at Sayn; four coal mines (Hanover, Saelzer, Neuack, and Hannibal), with interest in other coal mines; more than 500 iron mines near Bilbao, in northern Spain; firing range at Meppen, with a length of 10⅝ miles and a possibility of extension for 15 miles; three ocean steamers, several stone quarries, clay and sand pits, etc. In addition, the firm of Frederick Krupp operates the Ship & Machine Stock Co. Germania, at Berlin and Kiel, under contract.

The steel works in 1899 operated about 1,700 furnaces, forge fires, etc., about 4,000 machine tools, 132 steam hammers, more than 30 hydraulic presses (among them 2 of 5,000 tons each, 1 of 2,000 tons, and 1 of 1,200 tons pressure), 316 stationary steam boilers, 497 steam engines with an aggregate of 41,213 HP., 558 cranes of from 400 to 150,000 tons lifting power. During the last year the iron mines yielded an aggregate of 1,877 tons of ore per day. The coal production from the mines belonging to the Krupp Company (excepting the Hannibal) amounted, on an average, to about 3,738 tons for each working day. The consumption of water at the cast-steel works in 1899 was 15,018,156 cu. meters, which equals about the consumption of the city of Frankfort with 229,279 inhabitants. The consumption of gas in the steel works at Essen was 18,836,040 cu. meters in 1899.

On April 1, 1900, the total number of persons employed in the different works was 46,679, viz., 27,462 at Essen, 3,475 at the Gruson works at Buckau, 3,450 at the Germania works at Berlin and Kiel, 6,164 in the coal mines, and 6,128 at the blast furnaces and on the testing grounds at Meppen, etc.

THE DEMAND FOR ENGINEERS at the present time is well illustrated by the number of advertisements printed under "Situations Open" in this issue. Especially notable is the demand for competent men to take positions as professors and instructors in engineering schools. A half-dozen applications for men to fill such places have come to us recently, and two such openings, both in New York city, are advertised this week.

A COMPETITIVE EXAMINATION for the position of Inspector of Steel on the Rapid Transit Ry. of New York city will be held by the Municipal Civil Service Commission, Sept. 17. The subjects of the examination will be technical knowledge, experience, arithmetic and handwriting. The candidates need not be residents of the State of New York. They may be called upon to reside in towns where the factories are located. Further information may be obtained from Mr. F. C. Ireland, Chief Examiner, and application blanks can be had from Mr. Lee Phillips, Secretary of the Commission, New York city.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred at Forge Run, Pa., on the Pennsylvania Branch of the New York Central R. R. A freight train ran into a herd of cattle. The locomotive was derailed and overturned and the engineman, the fireman and a brakeman were killed.

A STORM OF EXTREME SEVERITY swept the coast of Texas and nearly totally destroyed the city of Galveston on Sept. 8. A conservative estimate places the loss of life at 3,000, and 5,000 families are shelterless and destitute. Not a building in the city escaped damage and nearly half of them were obliterated. There is immediate need for supplies of all kinds.

THE VERDICT OF THE CORONER'S JURY on the collision of Sept. 2 at Hatfield, Pa., was as follows:

We strongly recommend that the Philadelphia & Reading Ry. Co. strictly observe the five-minute rule in the running of all trains not guarded by some sort of block system. We recommend the continuation by the Philadelphia & Reading Ry. Co. of the Hall signal system to Bethlehem. We condemn John Davis, the engineer of the excursion train No. 249, for running past the red flag at the crossing at Souderton, for running his train ahead of time and running his train recklessly. We condemn Conductor Thomas Shelby, of the excursion train, for permitting Engineer John Davis to run recklessly and ahead of time, and for not ordering Davis to reduce speed. We believe that Operator D. B. Beidler, at Souderton Station, neglected his duty in his failure to raise the red board after the milk train had passed. We are of the opinion that the train despatcher, W. S. Groves, did not perform his duty, failing to keep in continuous touch with the milk train and the first section of the excursion train.

THE BRITISH SAFETY APPLIANCE LAW for the prevention of accidents on railways, received the assent of the Queen and became effective July 30. By it the Board of Trade is invested with extensive power, and is charged with the carrying out of the law. The Board may require the use of such appliances as it may consider best calculated to reduce the danger to persons employed. Penalties are prescribed for non-compliance with the rules.

TWO FIREMAN MAY BE REQUIRED on the heaviest locomotives in future. A conference of officers of the engineers' and firemen's brotherhoods is to be held at Topeka in early October, and it is said the plan of demanding two firemen on locomotives weighing more than a specified amount will be discussed. The practice of double-heading on freight trains, concerning which there has been some discussion in Kansas, is also to come up for consideration.

AN ELECTRIC ROAD, 44 miles long, is to be built from Grand Rapids to Muskegon, Mich., by way of Grand Haven. The track will be laid on a private right of way parallel to the country highways and the cars will be provided with 200-HP. equipments. The total estimated cost is $1,500,000.

STORAGE BATTERY CARS are being operated by the Metropolitan Street Ry. Co., of New York city, upon its 34th St. cross-town line. There are some quite severe grades upon this line, but the four cars already put on are working satisfactory and more cars will be added as soon as possible. The cars are equipped with motors and controllers furnished by the General Electric Co. The batteries are placed under the seats. A complete charging station has been fitted up at 42d St.

A METER FOR MEASURING TRACTIVE FORCE on electric or other cars was described by Herr Gisbert Kapp at a recent meeting of the Verband Deutscher Electrotechniker. His paper is translated in the London "Electrician" of Aug. 17, from which we abstract the following:

A tube is mounted in the car parallel to the rails, with the ends turned up to form vertical branches. Let us imagine the line to be horizontal and the tube filled with water up to a certain point in the vertical branches, which we will consider the zero point. In order to be able to observe the water level the vertical branches are glass tubes. If the tube is inclined to the horizontal the water level changes proportionately to the tangent of the angle of inclination, and an experimental scale can be marked on the branches with points corresponding to gradients of 1 in 1,000, 2 in 1,000 up or down, the position of these points being ascertained by trial. The distance of these points apart depends on the width of the branches and the length of the horizontal tube. If the car is at rest on an incline, the apparatus being, as already remarked, mounted parallel to the rails, the water level indicates with sufficient accuracy the horizontal gravity component per ton of rolling weight. That proportion of the tractive force which serves to overcome the gravity component can, therefore, be directly read off on the graduated glass tube when the car is proceeding up a steady incline. Let us now consider the car as moving with variable speed on a level track. The acceleration pressure acting on the horizontal column of liquid causes a displacement of the surface of the water. That portion of the tractive force which goes to accelerate the car, may, therefore, be read off on the empirically graduated scale, the level of the water in this case indicating both for the incline and the acceleration the necessary tractive force per ton of rolling weight. The apparatus indicates directly only that portion of the tractive force which is necessary for mounting the incline or producing the acceleration, not the remainder which is required for overcoming the friction resistance. To estimate this, the procedure is as follows: The car is set in motion on a length of track as nearly level as possible, and allowed to come to rest. The water level is read off, and indicates the retardation due to rails, gear, friction, etc. To eliminate the effect of any deviation from the horizontal, the test should be made running in each direction. The mean of the readings is the so-called traction coefficient expressed in kilogrammes per ton of rolling weight. When this coefficient has been determined it is only necessary to displace the scale by a certain fixed amount to enable the total tractive force to be read off.

THE ARCTIC EXPEDITION headed by the Duke of Abruzzi of Italy, has been heard from at Tromsoe, Norway, where the "Stella Polare," the ship in which the expedition sailed, touched on her return trip. According to the press despatch, the Duke reports that his party reached a point in latitude 86° 33′ N., which is north of the point reached by Dr. Nansen.

ASPHALT PAVEMENTS in Brooklyn are being ruined in many places, it is said, by leaking gas mains beneath them. The hydrocarbons used in enriching the gas are excellent solvents of asphalt, and so soften it in spots that it breaks up and crumbles, all to the loss and injury of the companies which laid the pavements and agreed to maintain them for a term of years. The gas companies, when brought to task for the injury done by their mains, however, pass on the blame to the electric railway companies, whose wandering return currents cause corrosion of the gas mains and consequent leakage. All of which goes to show that the troubles resulting from the overhead single-trolley electric railway systems have greater ramifications than is often realized.

A 1,340-HP. PARSONS STEAM TURBINE was recently tested at Elberfeld, Germany, by Herr W. H. Lindlay and Professors M. Schröter and H. F. Weber. The turbine is direct coupled to a polyphase generator and runs at 1,500 revolutions per minute. Using steam at 162 lbs. pressure with 14.3° C. superheat, the following results were obtained:

Dynamo output K-W.	Lbs. steam per K-W. hr.
1,190.1 (overload)	19.3
994.8 (full load)	20.1
745.3 (¾ load)	22.2
498.7 (½ load)	25.4
246.5 (¼ load)	33.8

Running with no load but with the fields of the dynamo excited the consumption of steam was 4.057 lbs. per hr., with the fields not excited the steam consumed was 2,604 lbs. per hr. 20 lbs. of steam per K-W. hr. is equivalent to about 15 lbs. per electrical HP. hr. The condenser air-pumpand dynamo exciter were driven from the shaft of the turbine. The speed regulation between no load and full load was 3.6%.

A NEW COMMITTEE ON STREET HYGIENE was appointed at the International Congress of Hygiene and Demography, held at Paris, France, on Aug. 12. This committee will make investigations and report at the next congress, to be held in Brussels in 1903 or 1904. It also intends publishing the results of its labors quarterly or semi-annually at Berlin. The officers are: Honorary President, Mr. Andreas J. Meyer, City Engineer, Hamburg; President, Mr. H. Alfred Roechling, Leicester, England, and General Secretary, Prof. Theo. Weyl, Berlin, Germany.

THE WACHUSETT DAM FOR THE METROPOLITAN WATER SUPPLY, BOSTON, MASS.

By Alfred D. Flinn, Assoc. M. Am. Soc. C. E.*

(With four-page plate.)

In February, 1896, the Metropolitan Water Board of Massachusetts began the construction of works for taking from the Nashua River an additional supply of water for the Boston Metropolitan District. The principal features of the Nashua River works are a large masonry dam and two earth dykes, a great reservoir in which the water of the river will be impounded by these barriers, and an aqueduct 12 miles long, connecting the new works with the existing systems supplying the district.

Within two years from the time of beginning work, the Wachusett Aqueduct was completed from the river, at the site of the proposed dam, to the Sudbury Reservoir, the last addition to the Sudbury River system, the development of which had been begun by the city of Boston. The deforesting of the reservoir area and stripping of the soil and other material containing organic matter from the bottom of the proposed basin, the building of new highways to replace those to be submerged, and the construction of temporary and protective works at the site of the Wachusett Dam were also begun promptly and have been steadily prosecuted. All of these works and the progress made in their construction have been described at various times in this journal.

The time has now arrived for the construction of the great masonry dam, proposals for which are invited in the advertising columns of this issue. Half a mile up-stream from the thickly settled part of Clinton, in a narrow rock gorge of the south branch of the Nashua River, is the site selected for the dam, and a map of the site is shown in Fig. 1. (Clinton is a town of 13,000 inhabitants, situated about 45 miles by rail westerly from Boston.) At the selected location the rock gorge is only 90 to 135 ft. wide, at an elevation 40 ft. above the lowest part of the rock surface, while at full reservoir level, elevation 395 above Boston City Base (approximately mean low tide), the distance across the valley from rock to rock is about 1,300 ft. The site has been very thoroughly explored by means of diamond and wash drills. The method used in making the wash drill borings was the common one of driving into the ground a pipe having an internal diameter of about 2½ ins. and washing the material encountered by the bottom of the pipe up to its top by means of a current of water discharged from the bottom of a smaller internal pipe, known as a wash pipe. The water flowing from the top of the pipe was discharged into a tub of sufficient size to allow the heavier materials to settle to the bottom, and samples of these materials were preserved and labelled.

In order to operate the diamond drills, a 2½-in. pipe was in each case driven into the earth down to the ledge rock or until stopped by a boulder, and cleaned out with a jet of water. The diamond drill was then lowered to the rock or boulder through this pipe. The cores obtained by drilling were also preserved and labelled. Most of the borings in the bottom of the valley were made from rafts floating on the mill-pond, where the maximum depth of water was about 20 ft.

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The notes and samples obtained were interpreted, after careful study, by Prof. W. O. Crosby, geologist of the Massachusetts Institute of Technology, who prepared a set of sections of the valley, which were elaborated by the drafting department of the Board and have been reproduced on eight lithograph sheets for the use of bidders. These drawings exhibit the character and probable arrangement of the various materials overlying bed-rock, and the general character of the rock and the profiles of its surface. One of these sections taken across the valley 10 ft. in front of the water face of the dam is shown in Fig. 2.

On the southwesterly side of the gorge the rock is a phyllite, mostly of a massive gray variety, which is dense and hard, but it contains also a few masses of softer carbonaceous schist, some coaly and some graphitic. On this side of the valley, the superincumbent drift is 20 to 60 ft. deep, being modified in the bottom of the valley (sands and gravels in irregular layers) and becomes, higher up on the hill, unmodified till or boulder clay. On the northwest side of the gorge the rock is a coarsely porphyritic granite, but lightly covered on the steeper slopes with sand and gravel, while on the bench in the hillside the drift attains a depth of 20 ft. or more.

The junction between the two rocks is evidently igneous, and at this place the softer schist was eroded by the preglacial river, so as to leave the granite rising abruptly above it in an escarpment 20 to 50 ft. high. This formation is clearly shown in Fig. 2. The fulness and unusual degree of accuracy of the information pertaining to the rock and its overlying drift thus obtained is considered to have been worth the large amount of money expended upon the borings.

The principal structures to be built under the contract now about to be made are the main dam, an up-stream gate-chamber, two terminal structures and a waste-weir of granite rubble masonry with exposed faces of granite ashlar and dimension stone; a waste pool below the dam, partly of granite masonry and partly of concrete, and a gate-chamber at the toe of the dam, and waste conduits to discharge into the pool. Fig. 3 is a perspective sketch of the proposed works as they will appear when completed.

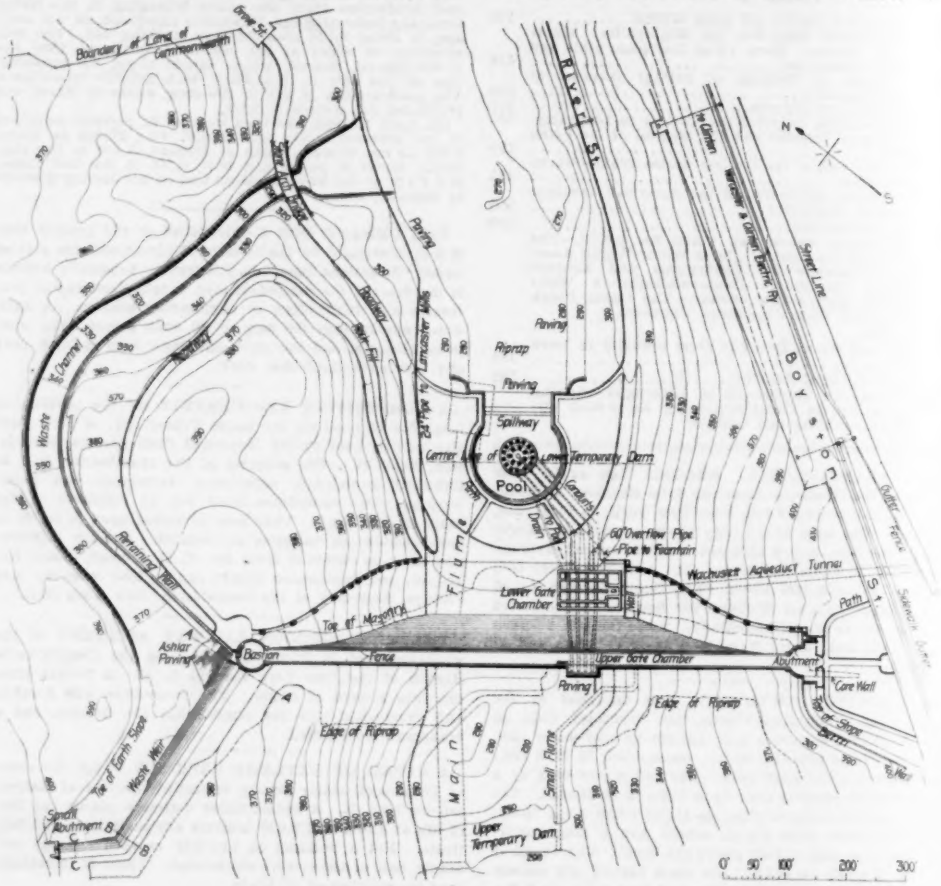

FIG. 1.—MAP OF SITE OF WACHUSETT DAM.

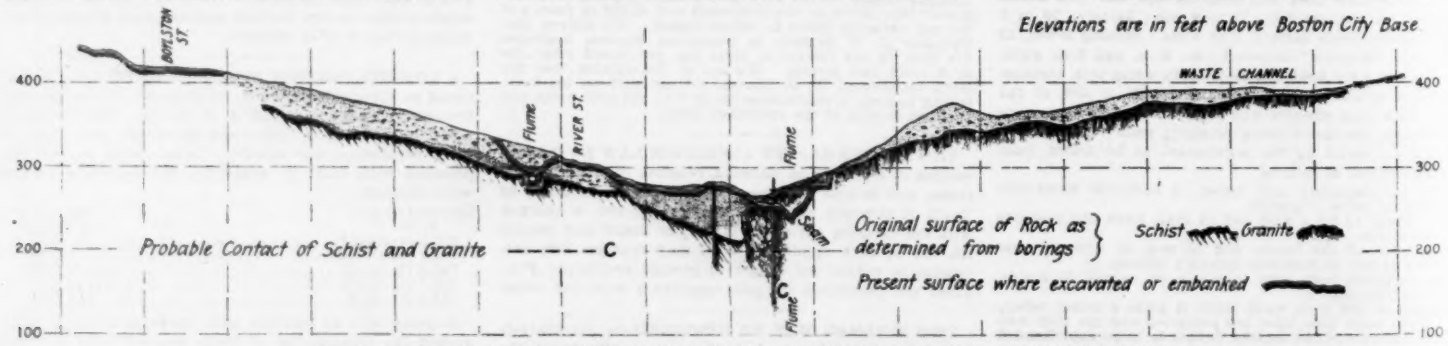

FIG. 2.—SECTION ACROSS VALLEY OF NASHUA RIVER AT SITE OF WACHUSETT DAM.

(Section taken 10 ft. in front of water face of dam.)

The Dam, Waste-Weir and Waste Channel.

The main dam will be 850 ft. long between the terminal structures, at the deepest part of the gorge will probably exceed 200 ft. in height above the excavated rock foundation, and in this part will be about 175 ft. thick at the bottom. The top of the dam will be about 145 ft. above the lowest place in the original earth surface, and 20 ft. above the proposed surface of the full reservoir. The extreme width across its top is to be 25 ft. 9 ins., and the least thickness under the

coping, 22 ft. 6 ins., at an elevation 9 ft. below the top. Fig. 4 on the inset sheet shows the form and principal dimensions of the cross-section, while Fig. 5 gives a cross-section at the deepest part of the valley and makes clear the magnitude of the structure. Those who are familiar with the cross-sections of modern masonry dams will recognize that the Wachusett Dam, although of the same general form, is much thicker than most of the existing dams. Immediately below the dam site is situated the large and rapidly growing town of Clinton, and the extensive Lancaster Mills, in which a very large number of operatives is employed, and still further down the valley there are important communities which would be endangered if the dam should break. In view of these conditions the engineers believed that they were warranted in increasing the thickness of the dam so as to furnish a much larger factor of safety than is usually adopted.

Excepting the exposed faces, the dam is to be built of rubble masonry of large granite stones, the sizes of the stones to be regulated by the ability of the quarry to furnish blocks of proper shapes and beds to insure thoroughly water-tight masonry. After excavating to satisfactorily sound rock, the foundation will be carefully cleaned, all small crevices thoroughly grouted, and the whole surface given a wash of neat Portland cement.

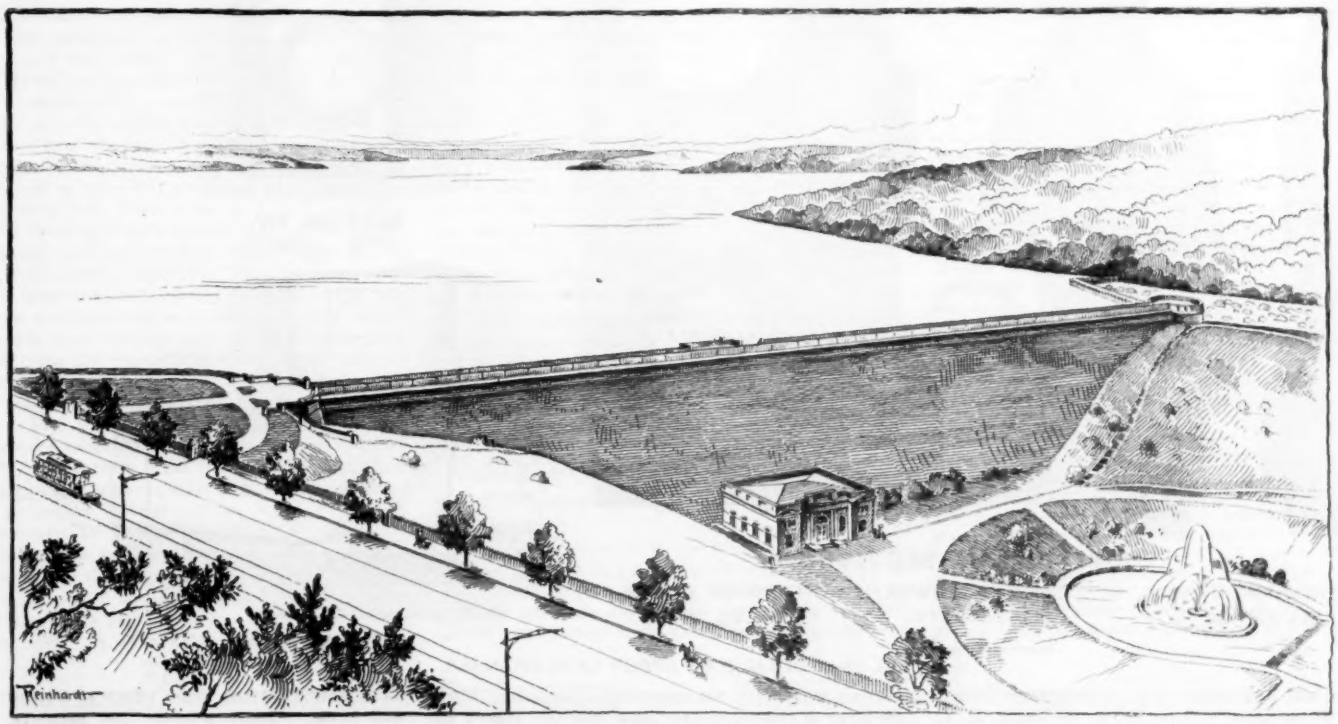

FIG. 3.—SKETCH OF THE WACHUSETT DAM AS IT WILL APPEAR WHEN COMPLETED.

Upon the foundation thus prepared, the first layers of masonry will be laid in 1 to 2 Portland cement mortar, and built solidly against the sides of the rock excavation. Portland cement mortar will also be used near springs and for masonry, if any, which may be laid in freezing weather. Otherwise natural cement mortar will generally be used for the rubble masonry, excepting for that portion in the bottom of the dam below a plane passing through elevation 260 in the down-stream face and inclining downward one foot in each two feet toward the back of the dam, which will be laid in Portland cement mortar. The faces will be of rock-faced granite ashlar in range courses, well bonded to the rubble by frequent headers. Further description of the masonry will be found below in the quotations from the specifications, and the figures on the inset sheet are also illustrative of the construction desired.

The main dam will cross the deeper part of the valley and terminate in a circular bastion at its northwest end, at the edge of the bench in the hill, and a semicircular abutment at its southeast end. The core wall, an extension of one of the horns of the abutment, will prolong the dam on the southeast slope for about 100 ft., but will be wholly buried from view by an embankment. From the bastion, the waste-weir will extend up-stream 350 ft. at an angle of 56° 46' with the line of the dam, and then turn and continue nearly parallel with the dam for 100 ft. to the ledge at the side of the valley above the bench, on which the weir is to be situated. The total length of the top of the dam, including core-wall and waste-weir, from rock to rock, will be nearly 1,500 ft.

The bastion (Fig. 9) is to be 50 ft. outside diameter, and within its upper part a chamber is to be formed in which the flashboards for the waste-weir and other materials may be stored; a flight of stone steps will be built in its down-stream wall and afford free access at all times from the ground to the top of the dam. The abutment (Fig. 10) will be flanked by retaining walls and backed by a large earth embankment which will prolong the dam practically to Boylston St., the adjacent highway, whose surface at this place is but 2 or 3 ft. above the top of the dam. A terraced path with frequent short flights of stone steps will lead from each terminal to the roadway across the bottom of the valley, in front of the dam, and is shown in Fig. 1.

For 100 ft. from the bastion, the crest of the waste-weir will be 3 ft. below F. R. L. (full reservoir level), to make possible the lowering of the water in the reservoir in anticipation of a freshet or for other reasons. The remaining 350 ft. of the crest will be at F. R. L. At the bastion the maximum height above present rock will be about 40 ft.; but at the shore end the weir will have but little height. Heavy castings for flash-board grooves will be bolted to the top of the weir at intervals of 10 ft. and provision made for flash-boards to an elevation 3 ft. above F. R. L., not for the purpose of impounding water to this higher level, but to prevent loss by waves over the weir. These are shown in Fig. 11.

For the waste-channel (Fig. 12) a favorable natural location exists. The channel will extend from the waste-weir to a point in the river channel about 800 ft. down-stream from the dam. In front of the waste-weir, only earth excavation will be necessary for the channel. From the bastion for 480 ft. a training wall will be built, but only about 200 ft. of it will have a height greater than 4 ft. Beginning 60 ft. from the bastion, a channel will be blasted in the rock, decreasing in width from 100 ft. to 35 ft., and increasing gradually to a depth of about 20 ft., which it is to have for a distance of 850 ft.

It is expected that it will be possible to discharge a run-off of eight water-shed inches in 24 hours, equal to 25,600 second-feet, over the waste-weir with a head of about 7 ft., and even then the water would be 8 ft. below the top of the lowest dam or dike of the reservoir; but so great will be the equalizing effect of the reservoir that it would require two days' continuous run-off at the rate named to reach this elevation, given a full reservoir to begin with. The upper half of the waste-channel is intended to have a capacity of six water-shed inches, while the lower half has been proportioned for only a 3-in. flow, because an overflow of the upper part, although not affecting the dam, might do serious damage to the grounds, but a flooding of the lower part would not have important consequences. Furthermore, a 3-in. run-off is about the maximum known flood, and even this is hardly expected ever to pass the weir after the completion of the reservoir.

The Gate-Chambers.

Two gate-chambers near the middle of the main dam, one on the up-stream and one on the down-stream side, will contain apparatus for regulating the flow of water in four 48-in. pipes embedded in the masonry through the dam, with centers 109 ft. below F. R. L. The pipes will be 11 ft. apart on centers in the upper gate-chamber, and 15 ft. apart in the lower. The upper gate-chamber (Fig. 14) will have no superstructure above the top of the dam. Its wells will be formed partly within the body of the dam and partly in a projection from the back of the dam. There are to be two vertical wells for each 48-in. pipe, extending from the bottom of the pipe to an operating floor 2½ ft. above F. R. L. The down-stream well of each pair will be 7 ft. diameter, and from its bottom the 48-in. main will start. The other well will be divided by a floor about 65 ft. below F. R. L., into two parts, the lower being 6 ft. diameter and containing a 48-in. valve for controlling the flow through a short 48.-in. pipe extending from the back of the dam to the 7-ft. well. These short pipes and their valves will be used during construction until water can be taken through the upper parts of these wells perpetually, and then these short pipes will be sealed. Above the floor just mentioned, these outer wells will connect with the reservoir by slots, 30 ins. wide, in the back of the dam, divided into ports 8 ft. high by lintel stones 2 ft. square in cross-section. Admission of water through these ports will be controlled by stop-plank gates and open frames placed in grooves in the slots, back of the lintel stones. In a second and a third pair of grooves, screens will be placed. Two openings, one about 65 ft. and the other about 33 ft. below F. R. L., and controlled by sluice-gates 2½ ft. wide by 6 ft. high, will afford

passage for the water to the 7-ft. wells and so to the 48-in. mains.

This narrower width of openings than has been frequently employed in similar places will make possible the use of shorter, and, therefore, thinner and lighter stop-planks; consequently, also, the total pressure on a stop-plank at any given depth will be correspondingly less—all of which will tend to facilitate the handling of the stop-planks. Likewise the narrower sluice-gates will be more easily moved. The passages for the water leading to and away from the openings will be liberal and the losses of head in the openings themselves will be trivial. By an inspection of Fig. 14 it can be seen that the arrangement is such that ordinarily the lower gate of each pair of sluice-gates can be operated under balanced pressures, and the head against the upper gate will not exceed 33 ft. Only on rare occasions, probably, will it be necessary to operate the lower gate with the 7-ft. well empty, and, even in the worst case, the head upon the gate will not exceed 65 ft., although the inverts of the 48-in. pipes will be 111 ft. below F. R. L.

The lower gate-chamber (Figs. 14 and 17) is to be the head-house for the Wachusett Aqueduct, and the foundation for a turbine house. Neither the power plant nor the superstructure of the house have as yet been designed finally. The substructure, which is to be built under the present contract, will be divided into four wells extending nearly the full length of the house and parallel to the dam. The well next the dam will be a dry well, and in it two 24-in. branches are to be taken from each 48-in. main. Each branch will have a 24-in. valve next the main, and will be deflected by a ¼-bend, or by a T combining two adjoining branches, and continued, with increasing diameter, so as to pass through the wall into the second well, where all will be connected to a 48-in. perforated steel pipe. By this means it will be possible to discharge water directly into this well without inconvenient commotion, despite the high head on the pipes. Into this well and the third the draft tubes of the turbines will discharge, and these two wells will have direct communication with the head of the aqueduct. The last well is to be an overflow and valve well. Here a 48-in. gate-valve is to be placed in each main. In the upper parts of the walls between the second and third and between the third and fourth wells there are to be nine arched openings 5 ft. wide, fitted with stop planks, to provide an outlet for the water in case it should reach an excessive height in either the second or third well. Across the fourth well, two 60-in. semi-cylindrical iron troughs will be placed with their lips a little above the level of the water in the waste-pool. From the down-stream end of each trough a 60-in. cast-iron pipe will extend to the waste-conduits. There will be no valves on these pipes, and hence they will always give free vent to surplus water. Fig. 14 is a cross-section through the dam and both gate-chambers showing the arrangement of wells and pipes just described.

When the reservoir is full or nearly so, the water, in passing from behind the dam to the aqueduct, will fall about 100 ft. The capacity of the aqueduct is 300 million gallons per day. Supposing the rate of flow to be two-thirds this capacity, or about 300 cu. ft. per second, the theoretical horsepower would be about 3,400. It is proposed to develop a part of this power and utilize it for generating electricity for commercial purposes. With so large a reservoir, the head and the supply of water to the wheels will be nearly constant, much more so than if the unequalized flow of the river were depended upon or if there were only an ordinary mill-pond.

From the down-stream sides of the 48-in. valves the mains will pass through the outer wall of the building and be prolonged for about 40 ft., with diameters increasing to 8 ft., at which point the material will be changed from cast-iron to concrete. From these beginnings, the waste-conduits will continue for 20 ft. to increase in diameter up to 10 ft., which size will be maintained to the inner basin of the waste-pool (Fig. 18), beneath which the four conduits are to be connected in pairs by two annular passages with flat bottoms and arched tops having large circular vents into the basin. This basin is to be 54 ft. in diameter, and its lip will be 2½ ft. above the level of still water in the concentric outer basin, which will be 150 ft. in diameter. The top of the wall of the outer basin, to which the ground will be graded, will be 7½ ft. higher than the level of the water in the restored mill-pond below the dam. From the pool, water will be discharged to the mill-pond over a masonry spill-way, or weir, 110 ft. long, with its crest 2 ft. above still water in the mill-pond. At the higher stages of the reservoir it is expected that it will be possible to waste 2,500 second-feet through the 48-in. mains, the conduits and the pool to the river.

The divergence of the waste-pipes and conduits on the down-stream side of the lower gate-chamber will cause the reduction of the velocity of the water in the conduits to about one-sixth that in the 48-in. pipes. Furthermore, the total area of the openings into the inner basin will be double that of the cross-sections of the four conduits, and so the velocity of efflux will be one-half that in the conduits, or only one-twelfth that in the 48-in. pipes. With the reservoir full the velocity in the 48-in. pipes would be about 80 ft. per second, that in the conduits 13 ft. per second, and the velocity through the orifices not over 6.5 ft., the head corresponding to which is only 8 in. Consequently the turmoil in the basin will be slight even when wasting to the full capacity of the pipes; and this will be accomplished in a distance of about 220 ft. from the gate-chamber. It is expected, also, that the diverging pipes will have somewhat the same effect as Venturi tubes, and thus increase slightly the capacity of the pipes for wasting.

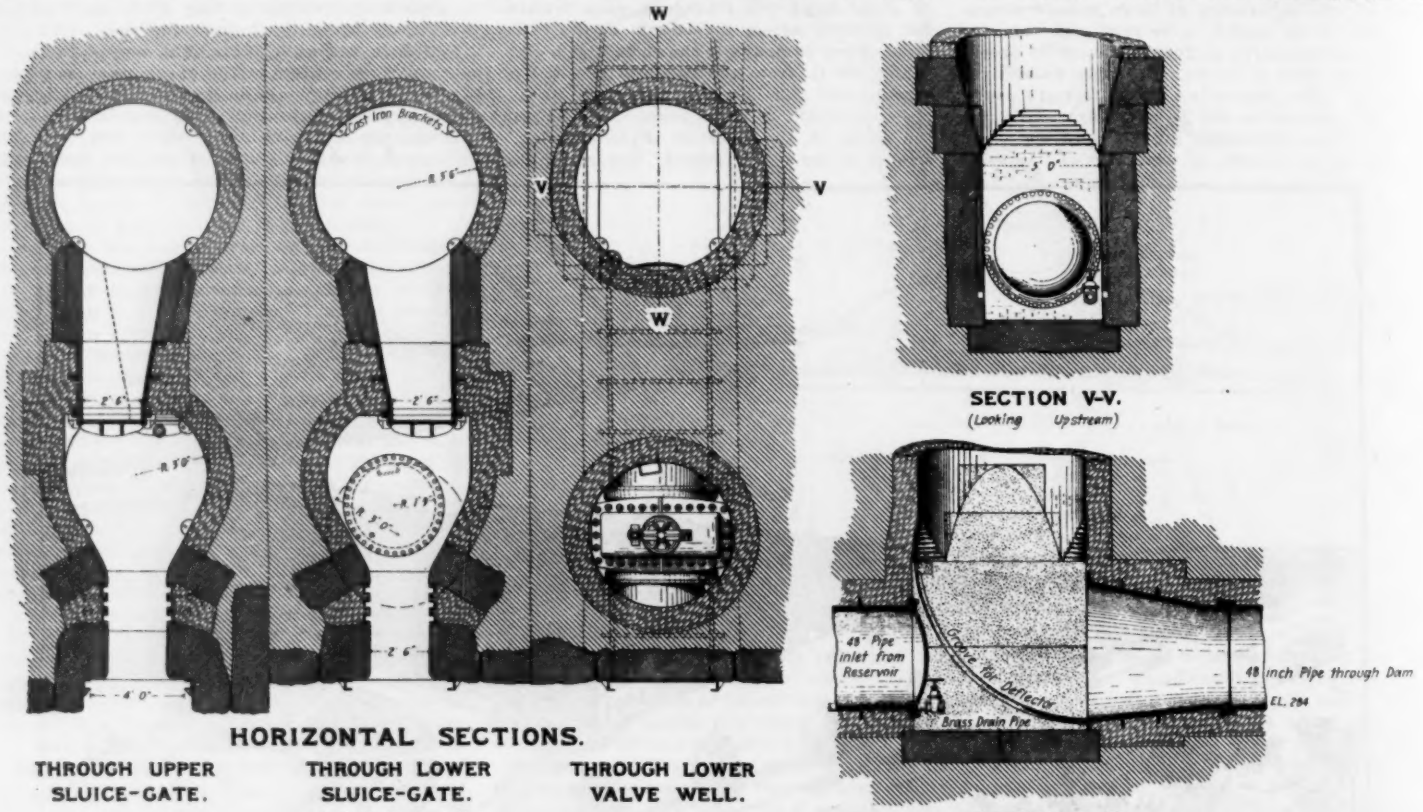

FIG. 16a.—DETAILS OF UPPER GATE CHAMBER.

Besides the structures that have been described, a short extension of the Wachusett Aqueduct is to be built to connect the tunnel with the lower gate-chamber. This will be of Portland cement concrete.

Aesthetic considerations have not been neglected in designing the works, and both structures and grounds will be treated in a manner to make them pleasing in appearance as well as serviceable.

As mentioned in previous descriptions of the Metropolitan Water-Works, the reservoir to be formed by the Wachusett Dam will be 8½ miles long, 2 miles wide at the maximum, and will have a shore line of 35 miles, a maximum depth of 129 ft., an average depth of 46 ft., and a capacity of over 63,000,000,000 gallons. This reservoir will thus have about twice the capacity of the one to be formed by the New Croton Dam, and, to the best of our knowledge, will be surpassed only by the Periyar, in India. The dam, at its maximum cross-section, will probably be the second highest in the world above rock foundation; the New Croton or Cornell Dam will be considerably higher.

Construction Works.

The board owns a site for a quarry about 1½

miles from the dam. A few trial openings indicate that a sufficient quantity of granite of satisfactory quality can be obtained here. A railway can be built from the quarry to the dam, with easy grades generally downwards toward the dam. The contractor will be permitted to take stone from this quarry without charge, but must provide the railway and other plant and appliances needed.

About 3,000 ft. down-stream from the site now chosen for the Wachusett Dam a small dam was built years ago to supply the Lancaster Gingham

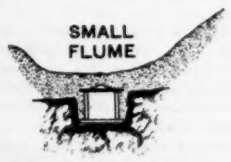

Fig. 19.—Section of Small Flume for Temporary Water Supply to Wachusett Aqueduct.

Mills with water for power and other purposes. During the construction of the aqueduct the Board took down a part of this dam and drained its mill-pond, so that protective works could be built for the big dam. A small earth dam (Fig. 20) was then thrown across the river about 275 ft. above the site of the masonry dam, to divert water into the aqueduct as soon as it should be finished and to keep the river out of the excavation. A flume 7 ft. 2 ins. wide by 7 ft. 7 ins. high was built from this dam to the head of the aqueduct tunnel, and is shown in Figs. 2 and 19. A second flume, 40 ft. wide (Fig. 21), has been constructed from this dam across the site of the excavations and through a lower temporary earth dam which is to exclude back-water in the river channel from the excavations. By actual experience in February, 1900, this large flume has proved capable of passing the largest freshet on record. Fig. 22 is a view of the flume during another very large freshet, which occurred March 2, 1900, before there had been any opportunity to repair the comparatively slight damage done by the preceding freshet.

Preparatory to the construction of the flume some earth and rock excavations were made at the site of the dam, in 1899. It had been hoped that the principal contract might be awarded in the spring of this year, as it was considered necessary to have the excavation for the main dam far enough advanced to make it possible to begin the laying of masonry in the spring of 1901 in order that the progress in the construction of the dam might keep pace with the increase in the demand for water and the consequent need for greater storage capacity in the reservoir. This did not prove feasible, as several unavoidable delays arose. To insure the desired stage of advancement of the work by next spring, it was finally determined to put a day-labor force at work upon the excavation for the main dam in the deepest part of the valley. On July 9, work was begun under the direct supervision of the engineer of the Dam and Aqueduct Department, is now being vigorously prosecuted and will be continued until the contractor is ready to carry on the work at not less than the same rate of progress. Figs. 23 and 24 are recent photographs of the pit. The excavations for the dam will be quite extensive, the trench having a maximum width of 400 ft. in the deepest part of the valley, and a maximum depth of 60 ft. or more.

Mr. Frederic P. Stearns is the Chief Engineer of the Metropolitan Water-Works, and the Wachusett Dam has been designed under his personal direction. Mr. Thomas F. Richardson is Engineer of the Dam and Aqueduct Department, and is the resident engineer on construction work connected with the dam. Mr. Alphonse Fteley, Mr. Joseph P. Davis and Mr. Hiram F. Mills are the consulting engineers. Excepting Mr. Mills, the gentlemen named are members of the Ameri-

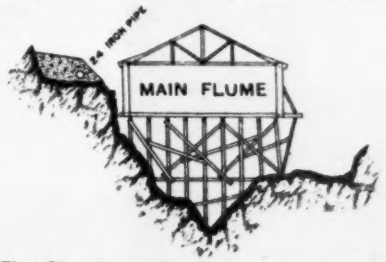

Fig. 21.—Flume for Passing Flood Water During Construction of Dam.

can Society of Civil Engineers. The mathematical studies and investigation for the dam were begun by Mr. Reuben Shirreffs, M. Am. Soc. C. E., formerly principal office assistant engineer, who resigned in January, 1899, to become Chief Engineer of the Virginia Electric Railway & Development Co., of Richmond. The studies have been continued and the contract drawings prepared under the direction of the writer of this article, who succeeded Mr. Shirreffs in charge of the designing and drafting department. Messrs. Olmsted Bros., of Brookline, Mass., have advised in matters relating to the landscape treatment of the grounds and structures.

The estimated approximate total quantities of the principal classes of work involved in the construction of the proposed dam and its appurtenances are:

Total earth excavation*	310,000 cu. yds.
" rock excavation*	110,000 " "
" masonry construction	290,000 " "

*Including that done by board.

The following are selected passages from the specifications:

Provision for Flow of River During Construction.

Sec. 7. If water runs over the top of the upper dam or over the top of either flume to an aggregate amount of 3,000,000 gallons in any 24 consecutive hours, and shall thereby cause damage to the work, the contractor shall repair the damage as soon as practicable, under the direction of the engineer, and if such overflow was not caused by the failure of the contractor to properly support such dam or flume or by some injury thereto as aforesaid, the engineer shall determine the actual cost to the contractor of such work of repairs, and the amount thereof shall be paid to the contractor. He shall not have any claim for damages for delay or otherwise in addition to the actual cost of the repairs as determined by the engineer, but shall be entitled to so much additional time wherein to perform portions of the work, and to perform and complete the contract on his part as the engineer shall certify in writing to be just. After the contractor begins to take down or reconstruct the large flume he shall be responsible for all damage caused by the water of the river.

Sec. 8. The contractor shall maintain the whole of the small flume in suitable condition for conveying water until such time as, in the opinion of the engineer, he shall have made suitable provision for conveying water through the 48-in. pipes and the gate-chambers into the aqueduct; he will then be allowed four days in which to remove the portion of this flume which is to be discontinued and to build up the opening through which the flume enters the side of the aqueduct, after which the water shall be allowed to flow, without interruption by the contractor, through the pipes and gate-chambers into the aqueduct.

Unless otherwise directed or permitted in writing by the engineer, he shall maintain the whole of the large flume in suitable condition for use, until he shall have completed the waste pipes and conduits to the small pool, shall have built the bottom of the inner pool to serve as an apron to receive the discharge of these conduits, shall have built large platforms and protective works, satisfactory to the engineer, to prevent the scouring of the material which is to serve as a foundation for the larger pool and of other earth, shall have laid a pipe to connect with the existing 24-in. pipe below the dam, and shall have raised the masonry of the dam southeast of the large flume to at least elevation 293. After these preparations shall have been satisfactorily made, so that the surplus water of the river can be diverted through the waste conduits and a supply of water can be furnished to the Lancaster Mills, the contractor shall, at a season of low flow in the river, complete the excavation of the rock under and near the flume, remove the flume and the 24-in. pipe where they cross the dam, and complete the masonry nearly to the level of the rest of the dam as rapidly as possible.

Both the order and the manner of doing this work shall be subject to the approval of the engineer, and if he shall so require, the contractor shall reconstruct the large flume where it crosses the dam, making it of such width not exceeding 15 ft., and of such height not exceeding 10 ft., as may be directed, and shall maintain such smaller flume until substantially all of the rock excavation and masonry below the level of its bottom shall have been completed.

Sec. 9. After the removal of the large flume the contractor shall keep the masonry of a portion of the dam in its vicinity, at an approved place, at a lower level than the rest of the dam so as to provide a sufficient spillway for any water that may overflow during freshets, and shall maintain a channel below the dam to carry the overflowing water to the river below.

Rock Excavation for Dam.

Sec. 32. The contractor shall excavate such rock as the engineer may deem necessary in order to provide a suitable foundation for the dam, and shall make such cut-off trenches and steps in the rock as he may require. In making this excavation he shall blast the rock to the extent directed, and with explosives of such power and quantity, and in such position that they will not crack the rock upon or against which, in the opinion of the engineer, the masonry may be built, and when, in his opinion, further blasting is liable to injure the rock upon or against which the masonry may be built, the contractor shall cease blasting and continue to excavate the rock by wedging and barring or other methods approved by the engineer.

Sec. 33. It is the intention to excavate a trench lengthwise of the dam, near its heel, for the purpose of more completely cutting off seams in the rock, and as this trench may in places be carried to considerable depths, it is desirable to make the sides as nearly vertical as possible, and not to disturb the rock at the sides of the trench by heavy blasting. Similarly, in places where it is the intention to build the masonry at the toe of the dam solidly against the side of the rock excavation, it is desirable that this rock should not be disturbed. The contractor shall, therefore, take special care in excavating the rock at these places, and shall do the excavating and blasting by methods approved by the engineer.

Sec. 35. From time to time, during the progress of the rock excavation for the dam, when so directed, the contractor shall remove from designated areas all rock which shall have been blasted or otherwise loosened, and all dirt, and shall thoroughly wash and clean the surface of the rock, using steam to melt snow and ice if necessary, and shall subsequently remove all water from depressions so that the whole surface of the rock can be inspected, to determine if seams or other defects exist.

Embanking Against Up-stream Face of Dam.

Sec. 41. The portion of the refilling and embankments within 10 ft. of the up-stream face of the dam, from and including the southeasterly abutment up to elevation 345 on the northwest side of the river, shall be made with boulder clay, from which all stones exceeding 3 ins. in their greatest diameter shall have been removed, deposited in layers not exceeding 4 ins. in thickness and thoroughly compacted by rolling with a heavy grooved roller, or thoroughly rammed where the roller cannot be used; or the clay, if free from large lumps, may be shoveled into

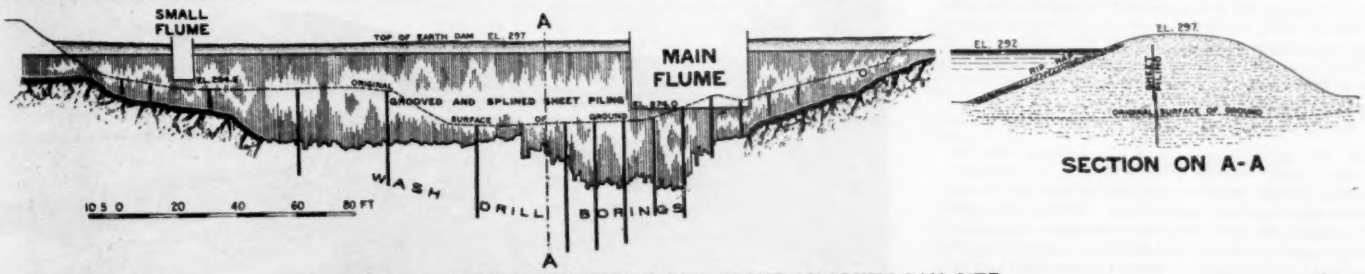

FIG. 20.—TEMPORARY EARTH DAM ABOVE MASONRY DAM SITE.

water in the manner required, in which case no rolling or ramming will be required.

Cement.

Sec. 47. All the cement will be subject to inspection and rigorous tests of such character as the engineer shall determine. It is the intention to use in the work only such cements as have a well-established reputation, and the contractor shall, therefore, submit to the engineer the brands of cement which he purposes to use. No cement shall be used which is not in all respects satisfactory to the engineer.

Sec. 48. The contractor shall at all times keep in store at the site of the work a sufficient quantity of the cements to allow time for 28-day tests to be made without delay to the work of construction. The engineer shall be notified at once of each delivery. Cement shall be stored in a tight building having a floor, and ample storage room shall be provided so that each separate lot of not more than 200 barrels can be stored in a way to make it convenient to identify each individual lot in case of its rejection, or in case of the necessity for further tests.

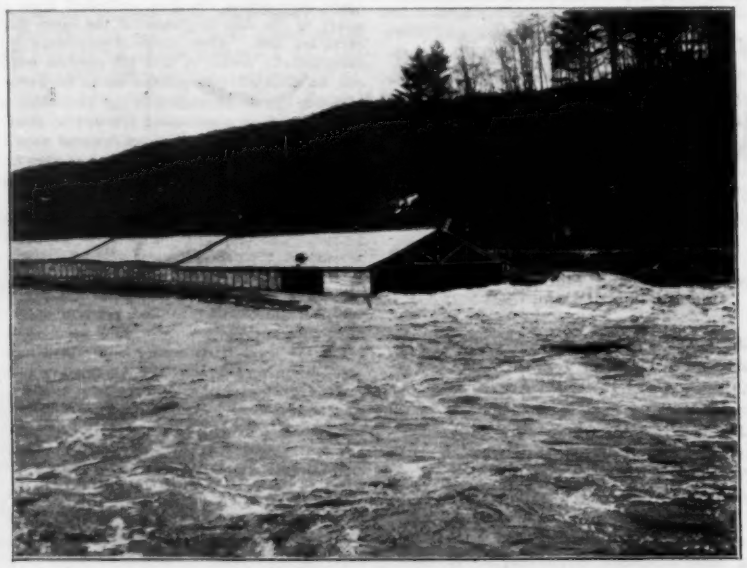

FIG. 22.—OUTLET OF FLOOD FLUME AT WACHUSETT DAM DURING FLOOD OF MARCH 2, 1900.

Sand.

Sec. 49. The sand used to make mortar shall be clean and sharp and of such sizes of grain as shall be approved. In the portions of the dam below elevation 395 and in other portions of the work where water-tight masonry is desired, the contractor may be required to furnish sand having grains of different sizes in such proportions as the engineer may direct, and when such sand cannot be obtained at one place, the contractor may be required to mix sands obtained from more than one place, so as to obtain the required proportions of the different sizes. He shall not be required, however, to obtain sand from places outside of the site of the reservoir, or more than 1¼ miles in a direct line from the main dam.

Stone.

Sec. 54. The stone to be used in the masonry shall be sound, clean, strong, durable granite. For the rubble stone masonry the granite shall be such that it will split so as to furnish even beds, and will furnish stones of suitable size and shape. For the ashlar and dimension stone masonry to be used in the top and the down-stream face of the dam, in the up-stream face above elevation 390 and in any other structure than the dam, the granite shall also be uniform in and of approved color and texture, and free from any defects which might injure its appearance. The granite from the land aforesaid when not stained or discolored is satisfactory in regard to strength, durability, color and texture, but the contractor shall not begin to use this stone for the ashlar of the down-stream face unless the quarry shall have been so developed as to show that sufficient stone of satisfactory quality can be obtained to complete this portion of the work.

Laying Masonry.

Sec. 58. The contractor shall not lay any masonry in water, nor shall he permit water to rise on any masonry until the mortar shall have set at least 24 hours.

Sec. 59. No masonry shall be built between the 15th of November and the 1st of April, nor at any time during freezing weather, or at night, except by the direction or special permission of the engineer. It is not the intention to direct or permit the building of masonry between the dates aforesaid, but if the amount of masonry laid to any given time is not as great as is required by the provisions of this contract, the engineer, if he thinks it necessary or desirable, may direct the contractor to continue laying the masonry through any part of the time between the dates aforesaid until he shall have complied with the provisions of this contract as to the rate of progress, and the contractor shall provide appliances for heating and shall heat the water, sand and other materials, shall cover and protect fresh masonry, and provide such steam or other heat as may be required to keep it from freezing, shall use salt to the extent required and shall lay the masonry as directed, all of this cold-weather work to be done in accordance with the special requirements of this section and of the engineer and without any extra compensation therefor.

All unfinished masonry shall be suitably protected during the colder months to prevent damage from freezing.

Sec. 60. During all of the year except the colder months the contractor shall keep all masonry wet by sprinkling with water until the mortar shall have become thoroughly set and hard enough to prevent its drying and cracking.

Order of Work.

Sec. 61. The masonry of the dam shall be begun at or near the bottom of the deep excavation and the top of the masonry shall be kept so nearly level that the difference in level between the highest and lowest part of the masonry shall not exceed 24 ft. in a distance of 100 ft., measured horizontally, or 45 ft. in the whole length of the dam, and no racking shall be more than 12 ft. in height, except as a greater difference in level or a greater height of racking is required for the purpose of taking care of the flow of the river or is required or permitted by the engineer.

Rubble Stone Masonry.

Sec. 66. In all parts of the dam except where otherwise specified or required by the engineer, and for filling low places immediately below the waste-weir in the waste channel, the rubble-stone masonry shall consist of stone of the quality above specified, laid in mortar, composed of 1 part of natural cement and 2 parts of sand.

Wherever the dam is sufficiently thick, large stones are to be used to the greatest extent consistent with obtaining full and water-tight bed joints and a sufficient space shall be left between the large stones to permit the filling of the joints with mortar and small stones. As the quality of the beds and the ability of the quarry to provide stones of large size are to regulate to a considerable extent the size of the stones to be used, the average size of the large stones cannot be fixed in advance, but may be fixed from time to time by the engineer, at any weight not exceeding 5,000 lbs. The engineer may also fix from time to time the maximum weight of stones, but not at less than twice the average weight. In the thinner portions of the dam, in the core wall, and in other thin portions of the masonry, the sizes of the large stones may be diminished to the extent that the engineer may deem necessary in order to obtain water-tight work.

The large stones shall have even beds which may be either flat or slightly convex, and not less than three-quarters of these stones shall each have a top with an area not less than half the area of the bed and varying from a parallel with the bed not more than 3 ins. in a foot. No large stone is to be used whose top area, as nearly parallel with the bed as above stated, is less than 2 sq. ft., if the area of the bed exceeds 4 sq. ft.

Sec. 67. Before laying, each stone shall be cleaned and washed, and all irregular projections and feather edges shall be hammered off. Each stone shall be laid upon a thick, prepared bed of mortar or of mortar and thin spalls, and forced into the bed in such manner as to insure that the bed joint shall be completely filled with mortar. To aid in the proper preparation of the bed, the contractor may be required to lower each stone upon the bed before it is fully prepared as a guide to its final preparation, and to remove the stone to complete the preparation of the bed. After the stone has been set, if there is any doubt about having obtained a completely filled bed joint, and occasionally, as a test of the quality of the bedding, the engineer may require that a stone shall be raised to ascertain if the bed joint has been completely filled, and such stone shall be rebedded in a thorough manner. The side and end joints between the large stones shall, if so required, be made large enough to permit the laying of small stones between them, and every stone, of whatever size, shall be laid in a bed of mortar. No more leveling up shall be done than is necessary. Grouting of joints will not be permitted.

Before laying any masonry upon the rock, the surface of the rock shall be given a thin coat of grout of neat Portland cement, to be thoroughly worked into all seams and crevices by the use of a broom or otherwise.

FIG. 23.—EXCAVATING WORK AT SITE OF WACHUSETT DAM, AUG. 20, 1900; VIEW LOOKING UP-STREAM.
(Deforested slopes in back ground will be submerged when the dam is completed.)

Bond.

Sec. 68. The stones shall be thoroughly bonded horizontally. Care shall be taken to avoid making regular layers and to permit a portion of the stones to project above others

to provide a vertical bond and to resist any tendency of the dam to slide. Toward the top of the main dam the strongest bond shall be made lengthwise.

Sec. 69. Wherever so directed, rubble-stone masonry shall be laid which shall differ from that specified by being laid in Portland cement mortar mixed in the proportion of 1 part of cement, to 2, 2½ or 3 parts of sand. It is expected that mortar composed of 1 part Portland cement and 2 parts of sand will be used for the portion of the dam immediately above the rock in the lower portions of the valley and wherever there are springs, and that Portland cement mortar may be used for work liable to be affected by freezing.

Sec. 70. From the bottom of the valley up to a plane passing through elevation 200 on the down-stream face and inclining downward 1 ft. in each 2 toward the up-

FIG. 24.—EXCAVATING WORK AT SITE OF WACHUSETT DAM, AUG. 20, 1900; VIEW LOOKING DOWN-STREAM.

stream side, the stone shall, unless otherwise directed, be laid in Portland cement mortar, mixed in the proportion of 1 part of cement to 2½ parts of sand. Of this masonry the portion between the down-stream face and middle of the dam shall be of a better class than that above specified, the stones shall be approximately rectangular so as to permit the use of fewer small stones for filling joints and leveling, and the securing of a more thorough bond. These stones shall be laid with bed joints inclined upward 1 in 4 toward the down-stream face, unless the engineer shall direct that they be laid with less inclination. For rubble-stone masonry of the better class described in this section, the contractor shall be paid an additional price per cubic yard.

Rubble-Stone Laid with Inclined Beds.

Sec. 71. The engineer may require that any portion of the rubble-stone masonry of any of the classes from A to D, inclusive, shall be laid with the bed joints of the stones inclined upward 1 in 6 toward the down-stream face, and for the masonry so laid the contractor shall be paid an additional price per cubic yard.

Up-stream Face of Rubble-Stone Masonry.

Sec. 72. The exposed faces of the rubble stones on the up-stream side of the dam shall be nearly rectangular and as a rule not less than 6 sq. ft. in area, but smaller stones may be used to a limited extent to fit in between the large stones. The aggregate area of the face stones having an area of less than 1 sq. ft. shall in no part of the dam be more than 10% of the area of that part. The face joints between the stones having an area of less than 1 sq. ft. and other stones shall not exceed ¾-in. in thickness, and the face joints shall in no place exceed 1 in. in thickness for 2 ins. back from the face. The joints shall be raked out before the mortar shall have become hard, to a depth of 2 ins., and shall be carefully repointed with Portland cement, clear or mixed with such proportion of sand as shall be required. The repointing is for the purpose of completely filling the joints with water-tight mortar, and shall be done with great care, at such times and in such manner as the engineer shall determine. This face work shall be paid for by the square yard of superficial area at the price hereinafter stipulated in addition to the price paid per cubic yard for rubble-stone masonry.

Concrete Masonry.

Sec. 102. Portland cement concrete masonry will be used for the walls and other parts of the lower gate-chamber, for the extension of the Wachusett Aqueduct, in the conduits between the lower gate-chamber and the pool, for portions of the pool, for the walk on the top of the dam, in the floor, walls and roof of the chamber in the bastion, in the upper gate-chamber, and for the foundations of the steps on the hillsides.

Natural cement concrete masonry will be used for parts of the foundations for the lower gate-chamber and pool.

Sec. 103. Concrete masonry shall be made of clean, sound, hard, broken stone or gravel stones and sand and cement of the qualities before specified. The stones shall be of varying sizes, none used in the natural cement concrete to be more than 2½ ins. and none in the Portland cement concrete more than 2 ins. in their greatest diameter.

If the stones before being broken are clean and they are not allowed to come in contact with the earth after being broken, the contractor will not be required to remove the dust and fine material, if the amount which will pass through a ⅜-in. screen does not exceed 10% of the volume screened. Should the amount of dust and fine material exceed the above quantity, the contractor shall remove the surplus or diminish the amount of sand used to the extent required by the engineer. The gravel shall be so thoroughly screened as to have all sand and dust removed from it.

The Portland cement concrete shall be mixed as required either in the proportion of 1 part of cement, 2½ parts of sand and 4½ parts of broken stone or gravel stones, or in the proportion of 1 part of cement, 3 parts of sand and 6 parts of broken stone or gravel stones.

The natural cement concrete shall be mixed as required either in the proportion of 1 part of cement, 2 parts of sand and 5 parts of broken stone or gravel stones, or in the proportion of 1 part of cement, 3 parts of sand, and 6 parts of broken stone or gravel stones.

Sec. 107. On the top of the dam, in the floors of the upper gate-chamber, of the chamber in the bastion and of the pool, and at other places where the engineer may so direct, the contractor shall finish the surface of the concrete by applying a wearing surface of not less than 1-in. in thickness of mortar, composed of 1½ parts of coarse, screened and washed sand, and 1 part of Portland cement. This surface is to be applied promptly, and in no case more than 1 hour after the concrete underneath shall have been placed, and shall be trowelled hard and smooth on top. This surface and the concrete beneath it shall be divided into blocks if and as required, and the surface shall be darkened by mixing with it such a quantity of lampblack as may be required. The surfaces when finished shall be even and true to the required form and equal in appearance to the best granolithic work. On the top of the dam special care shall be taken to make any joints which may be made between the blocks perfectly straight. This granolithic surfacing shall be paid for by the square yard at the price hereinafter stipulated, but shall also be included in the measurement of the concrete to which it is applied.

Drilling and Grouting.

Sec. 127. For the purpose of inspecting and testing the rock upon or against which the dam is to be built, it may become necessary or desirable to drill holes into the rock and to pour or force water or water and coloring into the holes, and to force in grout or other material for the purpose of filling seams or other cavities which may be encountered. The board reserves the right to do so much of this work as it shall elect by its own employees and without any payment to the contractor therefor, but if required the contractor shall do the work aforesaid and shall also force grout or other material into the pipes built in the masonry; all of such work to be done by the methods and in a manner approved by the engineer. The contractor shall receive as full payment for the satisfactory performance of this work its reasonable cost to him, as determined by the engineer, plus 25% of such cost. In determining the cost no account shall be taken of any of the general expenses of pumping, supervising and time-keeping, of the cost of power, power drills, steel used in drilling, nor of the cost of shovels, picks, hammers and other tools, plant and appliances, it being understood that the cost of such items and of all delay incidental to the work is included in the 25% aforesaid.

Special Work.

Sec. 128. It may become necessary or desirable to do certain work for which a price cannot be fixed in advance. The contractor shall do such work, when required, and shall be paid the reasonable cost of the work as determined by the engineer, plus 15% of such cost.

Use of Reservoir During Construction of the Dam.

Sec. 133. It is the intention of the board to utilize the Wachusett Reservoir for the storage of water during the construction of the dam, and the board therefore reserves the right to maintain the water against the main dam at elevations not exceeding those stated in the following schedule:

Period:	Elevation.
During September, 1902	292
During October, 1902	296
November, 1902, to March, 1903, inclusive	302
During April, 1903	310
May to October, 1903, inclusive	315
November, 1903, to October, 1904, inclusive	350
After October, 1904	395

Whenever the flow of water in the river exceeds the capacity of the 48-in. pipes, the water may rise to higher elevations than those given in the schedule, and the board may, at the risk of the commonwealth, maintain the water at such higher elevations whenever the water will not interfere with the operations of the contractor.

Time and Manner of Doing Work.

Art. V. The contractor shall commence work within 10 days after the execution of this contract by the board. The rate of progress shall be such that at successive dates specified portions of the work or the proportionate parts in value of the entire work shall have been performed as follows:

On or before Dec. 31, 1900, all earth required to be excavated to uncover the whole of the surface of the rock below elevation 280 shall have been excavated.

On or before Nov. 15, 1901, the masonry of the main dam between stations 4+50 and 6+40 shall have been built to an average elevation of 280; and so much of the lower gate-chamber, pool and other structures below the dam as the engineer shall deem it advisable to build during that year shall be built.

On or before June 1, 1902, the contractor shall have completed all of the works required for diverting and conveying the water through the 48-in. waste pipes and conduits and the protective works to prevent damage from the discharge of water through these pipes and conduits and shall have begun to remove the large nume.

On or before Sept. 1, 1902, the masonry dam shall have been built to such height that the lowest point in the up-stream third will be at or above elevation 300, and all work up-stream from the dam and below this elevation shall have been completed.

On or before Nov. 15, 1902, the masonry dam shall have been built to such height that the lowest point in the up-stream third will be at elevation 315.

On or before Aug. 1, 1903, not less than 62% of the total value of the work done and to be done under this contract shall have been performed.

On or before Nov. 15, 1903, not less than 76% of such value shall have been performed.

On or before Aug. 1, 1904, not less than 90% of such value shall have been performed, and

On or before Nov. 15, 1904, the whole work shall have been performed in accordance with the terms of this contract.

Damages for Delay.

Art. XVII. The contractor shall pay to the commonwealth all expenses, losses and damages, as determined by the chief engineer, incurred in consequence of any defect, omission or mistake of the contractor or his employees, or the making good thereof, and shall also pay, for each and every day that he shall be in default in building the masonry dam to such height that the lowest point in the up-stream third will be at elevation 315 as herein provided, the sum of five hundred ($500) dollars, which sum is hereby agreed upon, not as a penalty but as the damages which the commonwealth will daily suffer by reason of such default.

TESTS OF THE CORROSION OF PIPE by the earth along the route of the Coolgardie pipe line have recently been made. Specimens of pipe, both coated and uncoated, were buried at several different points in November, 1898, and they were dug up and examined on April 24, 1900. In all cases the pipe coating was found to be dry and friable, with a thin film of rust in places on the metal under the coating. There was no pitting of the metal, however. The pieces of uncoated pipe where buried in sand or clay were very slightly pitted. A piece of uncoated pipe buried in the "salt lake pan," however, was very materially affected, being covered with pits about 1-20-in. deep over its whole surface. Coated pipe in the same soil was not affected, as already stated, but it is not known whether pitting might not have occurred with longer exposure.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page [illegible]*XI-XXIII. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*

The calamity which befel the city of Galveston on Sept. 8 is the most serious disaster that has occurred in the United States for many years. From present indications the number of lives lost at Galveston and other points in Texas visited by the storm will exceed the number lost in the Johnstown flood of 1889, and also the number of fatalities in the similar storm which swept the Gulf coast in 1893. Doubtless in the present case, as in other similar cases of widespread devastation by storm or flood, the exact number of victims will never be known. The reports thus far received, however, show that a large part of the city's population (numbering nearly 38,000, by the recent census) are homeless, destitute, and in need of immediate provision of food and clothing. Relief funds have already been started in various cities in different parts of the country, and the Merchants' Association of New York city has organized a committee for the collection and disbursement of such a fund. Engineering News has accepted membership on the committee formed by this association, and will undertake to receive and turn over to this association any sums which its readers may desire to contribute. Doubtless many of our readers in other cities than New York, where similar funds are in process of collection, will prefer to subscribe to the fund collected in their own city, but others desiring to give to this worthy object may find it convenient to remit through us. All such contributions will be promptly turned over to the Merchants' Association treasurer, and suitable acknowledgment of each contribution will be made in these columns.

The meeting of the Central States Water-Works Association at Columbus, O., last week, narrowly escaped being a failure, so far as papers were concerned. The program was stretched out over three full days, but only three papers were read during that time, and the discussion on them was brief and of little importance. Notwithstanding these facts, more than 80 members and guests had registered up to noon of the second day, and 10 active and 5 associate members had been added to the membership roll. The majority of those in attendance seemed very well satisfied with such an outcome for the meeting, there being no lack of sociability among the members nor of provision for their entertainment—outside the convention hall. A number of those present, however, were of a different mind, and not only deplored the lack of papers, but urged that the papers should hereafter be printed and circulated in advance of the meeting, thus giving opportunity for discussions of more varied character and greater depth. The very same suggestion was made at the last meeting of the American Water-Works Association, where there was a dearth of valuable discussion, although there were papers in plenty. Both of these associations would do well to print their papers in advance, and both need a committee to determine whether or not the papers submitted are worth the time of the convention's and the cost of printing. The American Association has printed several papers, during the past ten years, that have seriously discredited it among all men having the elements of scientific training who have read them; one of the papers at Columbus last week falls in much the same category, although it did have the merit of being only moderately long. The Central States Association may be excused for an occasional slip, on account of its youth; and it was handicapped this year by the illness of its secretary. Then, too, it is of course true that the interchange of ideas in private conversation is often of much more value to those attending meetings of professional societies than the formal papers and discussions. As we said last week, there are so many conventions nowadays that it is no wonder if some are poorly attended, and if the members fail to do all that might be wished or expected. What is needed now is care to prevent the duplication of society work, co-operation between the different societies, more discriminating direction of their affairs and more thorough work on the part of the members.

A day of reckoning is coming for some of the electric street railways of the country that are failing to take proper care of their return currents. During the meeting of the Central States Water-Works Association, at Columbus, last week, Mr. C. W. Koons, of Mt. Vernon, O., said that pending a decision in an electrolysis case brought by the city of Dayton, O., he is keeping an account against the trolley company, debiting it with all labor and material required to replace services damaged by electrolysis. A sample of the pipe in question is properly labeled and saved for the "day of judgment." That the costs may prove to be heavy is indicated by Mr. Koon's statement that he has replaced one wrought-iron service pipes seven times in 13 months. This service is in made ground and extends beneath the tracks. Similar action is being taken by other water departments and companies, as at Peoria, Ill., where scores of tagged service pipe samples are carefully preserved (see paper by Mr. D. H. Maury, Jr., Eng. News, July 19, 1900). At the request of Mr. F. A. W. Davis, of Indianapolis, a committee was appointed by the Central States Water-Works Association to co-operate with committees from other societies to secure legislation to aid in stopping electrolysis. Water-works officials are on the right track in throwing the burden of electrolysis and its prevention on the electric railway companies, instead of seeking to find and apply a remedy of their own, as so many attempted to do at first.

The draft of a revised constitution for the New England Water-Works Association, just submitted to the members, is designed to make the written words of that instrument correspond with the unwritten law under which the organization has been working of late. The proposed changes are a unique example of bringing the letter up to the level of the spirit of the law, instead of the too common reverse practice. The revision was drafted by Messrs. Geo. A. Stacy, Chas. W. Sherman and Albert S. Glover, and has been adopted by the executive committee. It will be submitted to the membership for approval at the next annual meeting, on Sept. 19, 1900. It would repay those responsible for the conduct of similar societies to secure and examine a copy of this document. We do not claim that it possesses any novel features, but it does embody the principles and rules of action under which one of the most successful engineering societies in the world has attained its success, and now proposes to reach forward to still larger results. We shall not attempt an abstract or analysis of the revised constitution, since all the members have received copies before this time, and others can do so by addressing Mr. William Kent, Secretary, at the headquarters of the society, Tremont Temple, Boston, Mass. It may be noted for the benefit of any who have been misled by the name, that the New England Water-Works Association is by no means restricted to the six little (in area) commonwealths forming the northeastern corner of the United States, nor to water-works officials, only, but that

> water-works superintendents or other executive officers, commissioners or members of water boards, hydraulic engineers, sanitarians or other persons qualified to aid in the advancement of knowledge relating to hydraulic questions, shall be eligible as members.

It will be seen that there is no geographical limitation in this. The only distinction between New Englanders and others is that outsiders are called non-resident members and are asked to pay an initiation fee of only $3 a year, instead of $5. The association has a large membership throughout the United States and Canada and a few members in distant countries. Its numerous winter meetings in Boston and the loyalty of its members in supporting the association by reading and discussing papers, enables it to publish a quarterly journal which does much to attract members from outside New England.

The thing the association most lacks, it seems to us, is the publication of its papers, or at least the more pretentious ones, in advance of their presentation, in order to bring out more discussion. We say the more pretentious papers, because the success of the association has been largely due to the informal character of the monthly Wednesday afternoon meetings held through the winter. But many papers brimful of information are read at these meetings, as well as at the annual convention; and such papers need time for consideration if the best possible discussion is to result. Perhaps the old-fashioned debating societies of New England have made its water-works men more capable of impromptu discusions than those of other sections, but even if so, these discussions, particularly at the annual meetings, might have been much better in many instances if the papers had been available a few days before the convention. There is one thing to be commended in the program for the convention next week, and that is the ample time afforded for discussion by having no more than two papers at each session noted. Society convention programs are often so crowded with papers that there is no time for discussion. Another feature of the coming meeting at Rutland is the excursion in advance of the meeting, which includes the Berkshire Hills, Saratoga, Lakes George and Champlain, as set forth more fully in our Society Proceedings this week. Altogether, the coming meeting of the New England Water-Works Association promises to be very attractive, while the past work and future promises of the organization render probable a notable increase in its membership.

We have pointed out, in our discussion of the project for a $60,000,000 barge canal from Lake Erie to the Hudson River, that while certain commercial interests in New York city and Buffalo actively favor the enterprise, the country sections of New York are either apathetic or strongly opposed to it. As our readers will remember, an appropriation of $200,000 was made by the New York legislature last winter to provide for complete surveys and estimates for the proposed barge canal, and the work is now in progress. The friends of the enterprise were anxious that the recent Republican state convention should insert in

its platform a plank favorable to the radical improvement of the canals. The party leaders, however, were too well aware of the rural opposition to canal appropriations to accept such timber for their structure, and the plank as finally adopted, omitting a statistical statement of the decline of traffic on the canals, treats the canal enlargement project in the following non-committal style:

> The proper policy to be pursued with respect to the canals of the State is a subject of grave concern to the people. * * * * * * The last Republican Legislature appropriated the sum of $100,000 ($200,000—Ed.) to be expended in a thorough and scientific investigation of the cause of this decline in canal traffic and of the character and expense of all the numerous projects that have been proposed for the betterment of the canals and to bring about their greater use. It is the policy of the Republican party if any further expenditure of public money is to be made upon the canals, except for maintenance, to place before the people the assured facts, together with estimates the accuracy of which can be relied upon. It is obvious, however, that the canal problem is not merely one of an improved waterway. Connected therewith there is another—the problem of more modern transportation methods. This feature, together with the question of economic advantage to the States, should be thoroughly examined.

THE OUTLOOK FOR AN IRON AND STEEL INDUSTRY IN NOVA SCOTIA.

Probably no Canadian enterprise since the building of the Canadian Pacific Ry. has excited such interest in the United States as the organization of the Dominion Iron & Steel Co., to manufacture iron and steel at Sydney, Cape Breton. Nova Scotia has been known from very early days to possess rich coal deposits. It has also been known that these deposits had been developed and were being worked in a humdrum sort of a manner. In a similar general way it was understood that promising iron ore deposits existed in Newfoundland, but their possible commercial development had attracted little serious attention from Americans. When, therefore, the news was published a few years ago that the well-known capitalist and street railway magnate of Boston, Mass., Mr. Henry M. Whitney, had secured control of a large area of coal lands in Cape Breton and had consolidated the several small companies which were operating them into a single large concern, known as the Dominion Coal Co., it became a subject of considerable interesting speculation how the large output prophesied could be profitably disposed of.

To summarize the conditions as they appeared to American observers, the Canadian market for coal was small, and the possibility of developing a paying export trade seemed essentially doubtful. The probability of a European market was very remote, and to export the product to New England, which was the only logical market in the United States, required it to compete with American coals which had less volatile matter, were less smoky and far more popular, and which were protected by a restrictive customs tariff. It was to New England, however, that the organizers of the Dominion Coal Co. looked for their market. An attempt was first made to get the prohibitory tariff annulled by legislation; but this attempt failed. The announcement was then made by Mr. Whitney that he proposed to secure a market for the output of his mines by establishing a large by-product coke making plant near Boston, and to compete with the American producers for the New England market, not by selling coal, but by the separation and marketing of its constituent parts independently. The progress of this enterprise is familiar to our readers. Close upon its heels came the announcement in the autumn of 1899 that the same capitalists interested in the Dominion Coal Co. and the New England Gas & Coke Co. had awarded contracts for the construction of an iron and steel plant of large size at Sydney, Cape Breton, to manufacture iron and steel from Newfoundland iron ores and Cape Breton coke.

The sequence of events which finally led to the present attempt to establish the manufacture of iron and steel on a large scale in Nova Scotia is made quite plain from what has preceded. Naturally, Nova Scotia mining interests are very much elated over the prospect. Already another company has entered the field in the footsteps of the Dominion Iron & Steel Co., which, under the name of the Nova Scotia Steel Co., proposes to erect a still larger plant at North Sydney. This company, like its predecessor, has secured a large block of coal properties at a cost, it is stated, of $1,500,000, and will proceed to develop them and to erect coke ovens, blast furnaces, steel mills and shipbuilding yards. In a measure the conditions in Nova Scotia at present resemble very much the successive excitements which have occurred as one after another of the various iron districts of the United States have been exploited and developed. As in these earlier excitements also a great many reckless statements have been rife regarding the great extent and richness of the ore deposits, the remarkably close proximity of the ore, the coal and the limestone; the exceeding cheapness of pig iron production, and the superior availability of the iron markets of the world, and particularly of Europe, for disposing of the product.

In another part of this issue we have given an extended account of the coal and iron mines of the maritime provinces of Canada, and of the character and present state of development of those mines, which will be mostly drawn upon for the raw materials for steel making. The whole of this information has been gathered by personal observations and by various interviews with the company's officials, made during the recent Canadian excursion of the American Institute of Mining Engineers, by a member of the staff of this journal. In some instances it will be observed that the figures given out by the persons interested can be no more than paper estimates. In a large measure the field is a new one for iron manufacture, and there is no precedent to go by. From the facts and estimates given, however, a reasonably clear conception may be obtained of the outlook for the development of an iron and steel industry on a large scale in Nova Scotia. For convenience and clearness in summarizing these data, we may separate the discussion into a consideration (1) of the raw materials for iron manufacture; (2) the probable cost of manufacture, and (3) the available market for the manufactured product.

The raw materials for iron manufacture are iron ore, coke and limestone, and of these coal for coke making is the only one close to the works. The iron mines on Bell Island are 400 miles away by sea, and navigation is possible for only nine months of the year. Marble Mountain, the main source of the limestone supply, is 50 miles distant by water, and is also shut off by ice for three months of the year. So much for the geographical conditions governing the gathering of the raw materials. The Cape Breton coals are high in volatile matter, ash and sulphur, and deep mining is required to raise them. To make coke from them they have to be washed, to get rid of the ash and sulphur; at the works of the Nova Scotia Steel Co., at Ferrona, the cost of washing Cape Breton coal for coke making is put at 7½ cts. per ton. At the same works the coke yield in by-product ovens is given as from 73 to 74% of the coal. It will be recalled that at Everett, Mass., 71% is the average coke yield of Cape Breton coal. It is estimated that at the Sydney plant, using Otto-Hoffman ovens, the yield of coke per ton of coal will be as great as at the Everett plant, and that, based on the results obtained at Everett, the value of the by-products, ammonia, gas and tar, will be in addition about 74 cts. per ton of coal. The cost of the manufacture of the coke is also estimated at 40 cts. per ton in one of the statements made by the Dominion Iron & Steel Co. In another estimate, from the same source, we find the cost of producing a ton of coke, after subtracting the value of the by-products obtained, is given at $1.36.

Turning now to the question of the ore supply, it will be observed that the estimated cost of mining is given as 30 cts. per ton on board ship at the mines. This figure is said to be based upon actual cost in mining some 600,000 tons of ore. It is to be observed, however, that this ore was all obtained by open mining upon the surface outcrops. The portion of the Dominion Iron & Coal Co.'s seam for which open mining is practicable amounts to 3,000,000 tons of ore, after which underground mining, at a greater cost, must be resorted to. Including cost of mining and transportation, it is estimated that Bell Island ore can be laid down at the Sydney furnaces at $1 per ton. This ore averages about 55 per cent. metallic iron; 1.8 tons of ore being required to make one ton of pig.

With the preceding statements in mind, we are in position to understand the nature of the published estimate of the Dominion Iron & Steel Co. of the cost of making pig iron at their new works. Summarized, this estimate is as follows:

1.8 tons of ore	$1.80
1.25 tons of coke	1.80
0.75 ton limestone	.40
Labor, repairs and incidentals	1.50
Total	$5.50

It is interesting to note here that the Nova Scotia Steel Co., now operating on Bell Island ores and Cape Breton coke at Ferrona, estimates the cost of producing pig iron at Sydney at $5.50 per ton as long as open mining at Bell Island is practicable, and that when underground mining has to be resorted to the cost will not exceed $5.83 per ton. It will not be disputed, we imagine, that these figures are remarkably low, and it is certain that if they can be secured in actual practice the Dominion Steel Co. will be producing pig iron at as low a cost as anywhere in the world.

The market which the Dominion Iron & Steel Co. expects to possess is that of Canada, and being both protected by the heavy tariff on iron and steel and supported by a government bonus on each ton of pig iron which it produces, there is no doubt but that it can distance most competitors there. The market for pig iron and steel billets in Canada is, however, largely one which has to be developed. Canada manufactures at present only a very small proportion of the iron and steel articles which it consumes. Outside of Canada the markets which the company expects to reach are those of Europe. In reaching these markets the works have the advantage of a materially shorter route than is obtained from any of the Atlantic and Gulf ports of the United States. It should not be forgotten, however, that the problem of ocean transportation is not entirely one of miles, but is far more a question of securing a paying cargo for the return as well as for the outward trip. In this respect the South Atlantic and Gulf ports of the United States have much in their favor over any less busy route, however short it may be. Alabama pig iron was exported to Europe as ballast for cotton vessels during 1899 at the remarkably low rate of $3.25 per ton to Liverpool and Bremen.

In what has been said, reference has been had particularly to the mines and works of the Dominion Iron & Steel Co. Whatever conclusions we may come to regarding the commercial success of this enterprise, it will be remembered that one steel works does not make a great steel manufacturing industry. The plant of the Dominion Iron & Steel Co. has a capacity of 1,400 tons of steel per day, or about 500,000 tons of pig iron per year. Compared with other Canadian steel and iron works, this plant is, of course, of mammoth size, but it would be a very moderate sized plant in the United States. This comparison is not made in derogation of the Dominion Iron & Steel Co., but simply to make clear comparative values.

If the maritime provinces of Canada are to develop an iron industry at all comparable with those of America, England and Germany, as their people are now prophesying, a great many plants like that of the Dominion Iron & Steel Co. will have to be built. It remains to be seen, however, whether the requisite iron ore supply for such a growth is in sight. The Bell Island supplies aggregate only 34,000,000 tons. This is enough ore to keep a single plant running for a good many years, but it is instructive to remember that it equals barely two years' output of the Lake Superior mines. When it is exhausted where is the supply of ore to come from? Iron ore there undoubtedly is in Newfoundland and Nova Scotia, but what is its richness and uniformity, and what will be the cost of mining it and delivering it to the furnaces? These are all questions which must be answered satisfactorily before we are justified in assuming a much greater development of steel manufacture in Nova

Scotia than is now provided for by the companies which control the Bell Island ore deposits. There are, of course, the foreign ore deposits, those of Cuba and the Lake Superior regions, to be drawn from, but when the problem reaches this condition of affairs it seems to us that Nova Scotia's alleged advantageous position as a location for steel works disappears.

In what has been said we have merely attempted to jot down briefly some of the facts and impressions respecting the possibilities of steel manufacture in Nova Scotia which were gathered in the necessarily hasty visit of the member of our staff who accompanied the members of the American Institute of Mining Engineers in their recent visit to the mines and steel works of that province. That the Dominion Iron & Steel Co. will have the ordinary success of the successfully managed steel works in America we do not doubt, but we question whether its promoters are justified under the conditions in expecting anything more than this. As regards the further development of iron manufacture in Nova Scotia on a large scale, we think that it yet remains to be shown that the country possesses the necessary deposits of rich and cheap iron ores which will enable it to compete with other centers of iron production for the markets of the world.

LETTERS TO THE EDITOR.

Safe Slopes for Earthwork in Nicaragua.

Sir: In your issue of July 12, 1900, Mr. Thaddeus Merriman says in his letter concerning the stability of the clay cuts on the Silico Lake Ry., Nicaragua:

The general belief that all clay in this region will stand almost vertically for an indefinite time is a mistaken one, and it is my opinion that if all cuts were taken out at 1 on 1 in the first instance much future expense and trouble would be avoided.

In this Mr. Merriman seems to consider the observations and opinions of a great many able engineers who have looked into this question as being of no value. Engineering News has given considerable space to the discussion of this matter in the last few years, and it is my impression the belief is generally accepted, and I think the facts warrant the belief, that the clay in that region will stand for all time at very nearly vertical. My own experience covering a period of 13 years' labor in the Tropics proves this to be the case. The first 60 miles of the Guatemala R. R., from Puerto Barrios, runs through a country similar in all respects to that between Greytown and Lake Nicaragua. Nearly all of the grading was done on this line in 1883 and 1884. The cuts were all taken out on ½ horizontal to 1 vertical. The work was abandoned until 1893, when it was resumed, and the road completed for 134 miles. All of the cuts were found to be in good condition, and beyond clearing the roadbed again, very little work was required to put it in shape to lay the rails. However, not the least of many troubles was slides; but upon examination it was found in nearly every case to be due to a layer of harder or stiffer clay impervious to water, three or four inches or more in thickness lying parallel to the surface of the ground. Water which seeped through the ground to this layer would follow it downward until it found an outlet, and when an excavation cut through one of these seams there would be a slide, caused by a loosening of the earth above the flow of water. Such slides give never-ending trouble, and no proper slope can be given in the first instance which will avoid sliding. The proportion of these slips to the others is too small, however, to warrant an increase of the slope ratio on all others. The cuts on the Nicaragua Canal Co.'s Railroad were made in 1890 and 1891 while the writer was in charge of the construction of that road, and when he returned, in 1898, he saw no change in the slopes. The excavations on the Guatemala Northern Ry., the Central and its branches of Guatemala, the Honduras Ry., the Salvador Ry., the Nicaragua and the Costa Rica railways are all taken out with slopes of ½ vertical to 1 horizontal or steeper. Some of these lines have been in operation for more than twenty years, and the sides of the excavations stand perfectly well except as mentioned above, where springs occur. Here in Manaos, Brazil, almost under the equator, with the conditions about the same as in the interior of Nicaragua, except the soil is all clay as on the east side of Nicaragua, both the railroad cuttings made some six years ago, slopes 1 on 5, and excavations for streets, some of which are ten meters in depth with vertical sides, stand perfectly well. Very truly yours, H. C. Miller.

Manaos, Brazil, Aug. 19, 1900.

Setting Slope Stakes in Cross-Sectioning Earthwork.

Sir: Mr. Antonio Llano, in your issue of July 19, 1900, deduces formulas for calculating distances out to slope stakes when cross-sectioning for earth work. The writer has deduced formulas for the same purpose which he thinks even simpler and easier of application than Mr. Llano's.

Fig. 1 is the same figure given by Mr. Llano with some modification.

The side slopes of cuttings or fills are always stated by the ratio of the number of horizontal units to one unit rise, or the co-tangent of the angle made by the slope with the horizontal. Thus the slope $\frac{3}{2}$ is commonly designated a "one and a half to one slope." Therefore I designate the slope E F, S : 1 = S; the slope C I, S' : 1 = S'.

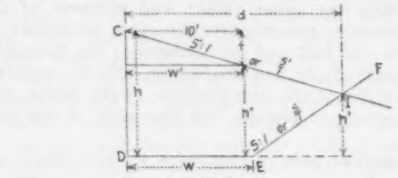

Fig. 1.

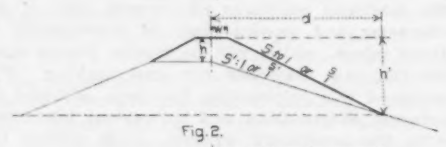

Fig. 2.

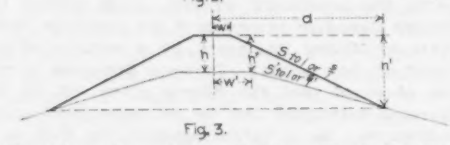

Fig. 3.

It needs no demonstration, that from Fig. 1, d = Sh' + w, also d = (h − h') S'; therefore, S'h − S'h' = Sh' + w, from which

$$h' = \frac{S'h - w}{S' + S}. \qquad (1)$$

If the slope C I is broken, then let w' = distance out to last break in slope, and h'' = the fill at that point. Then as before:

$$d = Sh' + w \text{ and } d = (h'' - h')\, S' + w',$$
$$Sh' + w = S'h'' - S'h' + w',$$

from which

$$h' = \frac{S'h'' + w' - w}{S' + S}. \qquad (2)$$

If the slope C I is in the same direction as E I, as in Mr. Llano's formulas, the sign before S' is simply changed. When h is so small that grade passes from cut to fill within w, change the sign before S. The formulas are equally applicable to both cuts and fills as all levelmen will understand.

In earth work S and w are nearly always stated. Assume that it is desired to cross-section a road bed, as did Mr. Llano, with base or crown of 20 ft., and side slopes 1½ to 1. Then S = 1.5 and w = 10. Substituting these values in (1) and (2), we have:

$$h' = \frac{S'h - 10}{S' + 1.5}. \qquad (3) \qquad h' = \frac{S'h'' + w' - 10}{S' + 1.5}. \qquad (4)$$

Now S' can be approximated very closely by taking the reading at the center stake or last intermediate and subtracting from it the reading 10 ft. out and calling this difference, or fall, f. Then $S' = \frac{10}{f}$, or any distance, divided by the fall for that distance. Substituting $S' = \frac{10}{f}$ in (3) and (4),

$$h' = \frac{\frac{10}{f}h - 10}{\frac{10}{f} + 1.5}. \qquad (5) \qquad h' = \frac{\frac{10}{f}h'' + w' - 10}{\frac{10}{f} + 1.5}. \qquad (6)$$

A small table of reciprocals from 1 to 100 will be found useful in the field to determine quickly $\frac{10}{f}$.

In very nearly level country the formulas are useless, but in rolling or very uneven countries if the leveler would accustom himself to applying the formulas he would find them a saving of time. They will be found especially handy if he has an inexperienced rodman.

In the enlargement and repairs of existing embankments, etc., such as is often necessary in levee work, S' becomes a stated quantity and the formulas then become exceedingly simple and easy of application.

Figs. 2 and 3 show two of the numerous [illegible] encountered. The light lines show the original [illegible] and the heavy lines show crown and slopes of added [illegible].

In Fig. 2, it will be readily seen that formula (1) applies changing the sign of S', $h' = \frac{-S'h - w}{-S' + S}$. In most cases, w = 2, S = 2, S' = 3; substituting,

$$h' = 3h + 2.$$

In Fig. 3, formula (2) applies, changing signs as before, w = 2, S = 2, S' = 3; substituting,

$$h' = -3h'' + w' - 2. \qquad (8)$$

w' is very often constant, and is usually 4, and [illegible] = h, w' being level, these put in (8), gives:

$$h' = -3h + 2. \qquad (9)$$

It is understood, of course, that in all instances where h' is determined d is obtained from the formula d = Sh' + w. Yours respectfully,

A. Miller Todd, U. S. Inspector.

Greenville, Miss., Aug. 11, 1900.

Sir: A letter in Engineering News of July 19 [illegible] the subject of cross-sectioning is doubtless typical of scores of letters that are received by technical papers each year. The writer in each case imagines that the publication of his formulas will be of great assistance to the field engineer. It is safe to say, however, that the practical man will ignore every formula or method that involves much calculation, or in any way adds to his mental labor.

In order to reduce to a minimum the work of finding the points where slope stakes must be set, the writer some years ago devised a level rod which, in conjunction with a specially graduated tape, makes the setting of slope stakes entirely automatic; and so greatly facilitates the work that 50% more stakes may be set in a day than by ordinary processes.

I shall first describe the graduation of the tape and the construction of the rod, afterward indicating the use thereof. Take any ordinary linen tape graduated in feet and tenths, and beginning at the zero end lay off on the tape half the width of the proposed road bed. If the road bed is to be 20 ft. wide, lay off 10 ft. on the tape, then turn the tape over and on its blank side and directly opposite the 10-ft. mark paint 0 with india ink. Beginning at this new 0 point make a series of marks 1½ tenths apart. If the side slopes of cuts are to be 1½ to 1; but, if the side slopes are 2 to 1, make the aforesaid graduations 2 tenths apart. Next paint over each mark its proper denomination, beginning at 0 and progressing exactly as any tape is graduated. Fig. 1 shows the front face of the ordinary engineer's linen tape. Fig. 2 shows the rear face of the same tape graduated as just described. The graduations need be carried out only as far as the probable distance of any slope stake from the base line. The rod is somewhat more difficult of construction, but is withal simple and inexpensive. It consists of a strip of white pine 1 × 2 ins. × 10 to 14 ft., dressed so as to leave a bead on each side, as shown in cross-section, Fig. 3. Passing around the rod lengthwise is a movable endless tape graduated from the top downward; that is, in exactly the opposite direction to the graduations of the common self-reading rod. The ends of the rod are rounded, as shown in the side view, Fig. 5, so that the tape will slip readily. The tape should be 1 in. to 2 ins. wide; but, as the writer has been able to find no suitable tape in the market of this width, he has made one by cutting an ordinary 100-ft. linen tape into three pieces, laying two of the pieces side by side, blank face down, and the third piece on top of the two. The third piece is then sewed onto the two pieces, preferably by a shoemaker, the result being a tape 1¼ ins. in width. Stretch a section of this prepared tape, fastening it with thumb tacks to a table, and graduate carefully in feet and tenths, marking with a pencil. Upon this tape stencil the feet and tenth figures, progressing from the top down. Stencils may be cut out of cardboard and the outlines marked on the tape with a pencil, afterward filling it with india ink. The block form of figures shown in Fig. 6 enables one to read to the .01 ft. The graduated tape is stretched around the rod with about the same tension used during the process of graduation, and a mark is made where the tape is to be spliced;

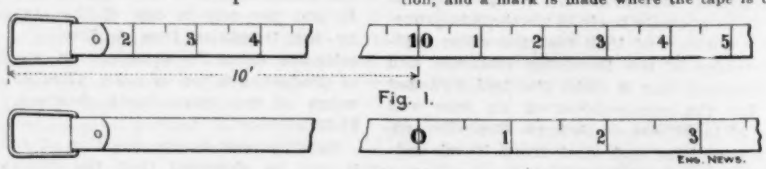

Fig. 1.

Fig. 2.

FIGS. 1 AND 2.—METHOD OF GRADUATING TAPE FOR CROSS-SECTIONING.

it is then taken off and a soft leather splice sewed on so as to make the tape continuous. To get the tape back on to the rod it is necessary to bend the rod slightly in the form of a bow and slip the tape over the ends. The tape is held in place by small wire staples that span the tape and are driven into the rod at intervals of about two feet. The ends of the rod are protected by U-shaped strips of brass, as shown in Figs. 4 and 5. It would seem that rollers should be provided at the ends of the rod upon

which the tape would travel with ease, but the writer has found it an unnecessary. It might also seem desirable to provide some sort of a clamp to prevent the slipping of the tape after a reading of the rod has been taken, but this likewise is not needed.

The operation of setting slope stakes, using the tape and rod prepared as above described, is as follows: Assuming that the stake setting begins at Station 0, and the proposed Grade Elevation is 121.0, while the nearest Bench Mark elevation is 127.32, set up the level at a convenient place, as shown in Fig. 7, hold rod on B. M., and move the endless tape up or down until rod reads the difference between the B. M. elevation and Grade Elevation, in this case 6.32. Next hold rod on ground at center stake at Station 0, the rod reading will give the center cut direct without further calculation. Next move the rod out to a

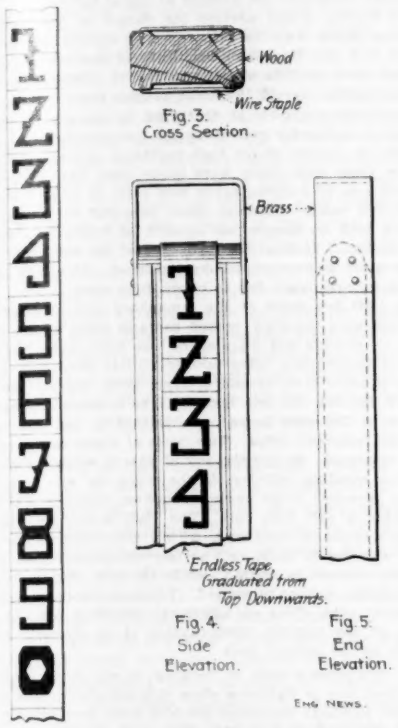

Fig. 3. Cross Section.

Fig. 4. Side Elevation.

Fig. 5. End Elevation.

Fig. 6.

Figs. 3, 4, 5 and 6.—Level Rod for Cross-Sectioning.

point where it is estimated the slope stake should be set, and let us assume that the rod reading is 7.3. Measure with the specially prepared tape (shown in Fig. 2) from the center stake to the rod, holding the end of the tape at the stake. If the tape reads 7.3, the spot where the rod stands is exactly the right place for the slope stake; if, however, the tape reads, say, 6.6, then move the rod a few tenths further out and read rod and tape again, repeating the operation until the rod and the tape read exactly alike, and at that point drive the slope stake, marking thereon the rod reading, which will be the cut.

It will be seen that no calculations at all are involved in this method of slope-staking, except the preliminary calculation for the first rod reading, and that errors are practically impossible. Should the grade be + 0.5% from Station onward, it will be necessary to move the tape down 0.5 ft. before taking rod reading at Station 1, and a like amount at each succeeding station.

When a fill is encountered it becomes necessary to hold the rod upside down, both on B. M. and ground. This can be done without error, since the figures on the rod

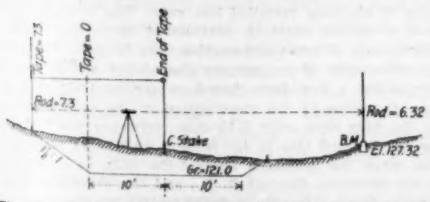

Fig. 7.—Sketch Illustrating Method of Using Rod and Tape in Cross-Sectioning.

are equally clear when reversed. If, however, it is feared that errors may be made, another rod should be constructed similar to the one described except that the figures should progress from the bottom upward; one rod being used for cuts, the other for fills.

The automatic leveling rod is as useful for running a line of profile levels as for cross-sectioning, the operation being as follows:

Hold rod on B. M., whose elevation is, say, 127.32, and set the endless tape so that the last three figures, namely, 7.32, are read on the rod, then wherever the rod is held, the rod reading will give the elevation of the point upon which it is held by prefixing the first two figures of the bench mark, namely 12. In other words, the rod readings give the elevations of the ground or bench mark direct and without calculation. When it is desired to move the level forward, take a rod reading on the turning point, say 1.24; move the level forward, set up, raise or lower the endless tape until the rod again reads 1.24 and proceed as before. It will be observed that the rod automatically adds or subtracts, thus relieving the instrument man of all mental labor; while the notes are kept entirely in one column which is at once the rod reading and ground elevation.

Engineers who are fond of harping upon the great exactness of their leveling will raise the objection that an automatic rod such as described will give results altogether too approximate. With them the writer can not agree. It is seldom that grading closer than 0.05 to 0.1 ft. is required on any work; and for such purposes a rod read to hundredths on B. M.'s and tenths on the ground is sufficiently exact. Reading rods to thousandths on B. M.'s and hundredths on the ground is one of those absurd time-consuming practices with which the writer has no patience; and it is observable that the engineer that reads to thousandths is the one that oftenest makes mistakes of feet.

While the writer has an application for patent pending on the rod as above described, no one who makes such a rod for his own use will be prosecuted, and a few hours spent in preparing a tape and rod will be saved tenfold on even a short line of road or railway cross-section work.

H. P. Gillette.

751 Powers Block, Rochester, N. Y., Aug. 4, 1900.

Notes and Queries.

W. S., New York city, asks what is meant by a "watch tackle" in bridge erection; also whether turnout curves are more commonly set out by offsets or by deflection angles.

E. B. asks for authorities on the methods of constructing gravity coal pockets. Also, at what angle will coal run on a wooden floor, and what is the angle of repose in a pile of coal of different sizes?

In Engineering News of Jan. 26, 1899, will be found a description and drawings of the coal storage bins of the Capital Traction Co., of Washington, D. C. A series of letters on the formulas to be used in proportioning coal bins appeared in the following issues: Nov. 4 and Dec. 30, 1897, and Jan. 27, March 3, April 7 and May 5, 1898.

W. H. A. writes: "Can a concrete arch bridge be said to have both substructure and superstructure? and, if so, where is the dividing plane located?"

Certainly the arch itself is a "superstructure," as much as if it were made of metal or wood, and as certainly the part resting on the foundation bed is a "substructure." Usually the dividing plane would be located at the top of the abutment, and in the construction it is common to emphasize this line by a projecting ledge or molding.

A LOUD-SPEAKING PHONOGRAPH has been invented by Mr. H. L. Short, of Brighton, England, and is described by the London "Electrician" as follows:

In appearance it is merely an ordinary phonograph, with a large trumpet, measuring 4 ft. in length. Inside this trumpet there is a small and delicate piece of mechanism that looks something like a whistle. This is the tongue of the machine. Instead of the "records" being taken on wax, in the usual manner, a sapphire needle is made to cut the dots representing the sound vibrations on a silver cylinder, and when the needle travels over the metal a second time the vibrations cause the whistle to produce a series of air waves and the machine thus becomes a talking siren, which transforms the human voice into a deafening roar. Experiments have been made near the Devil's Dyke, Brighton, where the inventor has his workshops. The instrument was placed on the roof of the laboratory and was made to repeat a number of sentences. At a distance of ten miles, it is said, the sounds were plainly heard by a large number of people; every word being perfectly distinct, and at a second trial, with favorable wind, it was found that an unknown message could be taken down in shorthand at a distance of twelve miles.

The possibilities in such an instrument are not pleasant to contemplate. If it works, and the campaign managers get hold of it, they can literally cover the country with their speeches and pour arguments into the ears of voters whether they will or no. Of course, the apparatus would have obvious uses, as for sound signaling between vessels, but its operation would have to be regulated by legislation.

EXPERIMENTS ON METHODS OF SEWAGE DISPOSAL AT LEEDS, ENGLAND.

The city of Leeds, England, has been engaged for over two years in experiments upon methods of sewage disposal. Chemical precipitation works have been in operation there for a long time, but the amount of sludge to be disposed of—some 300 tons per day—and the imperfect purification effected have become so troublesome that some better method of disposal has become an urgent necessity. The results of the experiments have just been made public in an elaborate report. Hon. Wm. T. Hunt, Chairman of the State Sewerage Commission of New Jersey, writes us that on a recent trip abroad to inspect foreign systems of sewage disposal, he found that the experiments at Leeds were being conducted on a broader and more hospitable plan than anywhere else. Nearly every method having any promise of practical value was given a fair trial. We are indebted to Mr. Hunt for a copy of the conclusions of this report, in which the commission in charge of the experiments sums up the results of its work up to the present time. It presents in small compass so complete a statement of the experience with the recent processes of sewage diposal that we print it in full, as follows:

All the experiments in biological treatment showed the remarkable purifying effects of bacterial oxidation, and that it was more rapid in dealing with dissolved impurities than with solids in suspension, many of which are but slowly reduced.

Double contact beds gave good results with crude sewage and excellent results with partially settled sewage or septic effluent. Single contact beds are insufficient for dealing with crude sewage, but gave fair results with settled sewage or septic effluent. The real difficulty with contact beds is to maintain capacity. No doubt the loss of capacity is due partly to degradation and consolidation of the material of the beds; but even if material can be found of even size and not liable to break up, and even if the bulk of solids in suspension is first settled, the choking up of the beds would be likely to arise sooner or later. The hope that the accumulation would be dissolved by rest has not been fulfilled at Leeds. The beds, however, digest a large part of the suspended solids put upon them, but only by working them at the rate of one filling per 24 hours could the continued life of the rough bed be secured, and even then the ultimate choking seems inevitable, owing to retention in the beds of matters which have reached an irreducible condition.

It is proposed, before finally abandoning contact beds for the treatment of Leeds sewage, to try experiments with beds so constructed that they will pass out undigested matters with the effluent non-putrescible matters which will be afterward settled.

The continuous filtration of sewage or septic effluent on fine beds, although giving very good results, would appear to be impracticable on account of the rapid choking of the beds. On the other hand, continuous filtration over very coarse material, of septic effluent, and even of sewage, has given interesting and remarkable results, if the solids in suspension, which come out in the effluent, are settled after filtration. These solids are non-putrescible, can be readily settled, and the drying does not give rise to evil odors. It would seem that the coming through of these solids, which for the most part are not further reducible and largely mineral, ensures the permanences of the coarse continuous beds.

It has been found practicable, for long periods, to work coarse continuous beds 10 ft. deep at the rate of 200 gallons per square yard, or 1,000,000 gallons per acre per day for septic effluent. At this rate results giving over 90% purification are obtained, after settlement of solids coming out in the nitrate, and, although at this rate some of the solids are retained in the filter and there accumulate, they can be washed out by increased flow which naturally arises with storm dilution. This possibility of dealing with storm waters is an important feature of the system.

It would seem practicable to deal on such beds even with crude sewage (previously strained through several screens), but in this case a depth of 12 ft. of material would be required for Leeds sewage, which is not very strong. These latter experiments have not been carried on long enough to draw from them any definite conclusions.

With continuous beds the chief difficulty will be that of distribution, the ideal being an equal rain of sewage over the whole surface, and difficult of accomplishment on a large scale.

The experiments will be continued, and it is proposed, in constructing new experimental "Leeds" beds, to avoid artificial heating of the sewage, which it is feared, will prove too costly, and to so construct the beds that they may, as far as possible, conserve the heat of the sewage, which, even in winter, is always many degrees over freezing point. No doubt this question of retaining the heat of the sewage is one of the difficulties of continuous filtration. There is very little loss of heat in contact beds.

Experiments are proposed to secure a material of even size and form, and not liable to become broken up, and this is not less necessary for the permanent life of the continuous than of the intermittent filters.

Neither the continuous or the intermittent systems of

filtration give rise to any evil odors. Both give excellent results on chemical analysis, and effluents which improve and do not deteriorate on keeping. From the bacteriological point of view, however, all the filtrates contain a greatly larger number of bacteria than the standard of numbers allow for drinking waters. This objection is not very material, as it is quite impracticable in the treatment of sewage, to require transformation into liquid of a potable quality. Indeed, the presence of bacteria in the filtrate may be looked upon as an active element of further purification, and it is only to be remembered that the presence of a large number of beneficent bacteria is always accompanied by a proportion of pathogenic species. Where filtrates proceed from fever hospital sewage, for instance, or where filtrates pass to streams which are used for drinking purposes, some process of final sterilization, with a view to the extinction of pathogenic germs, may be desirable; but in the case of Leeds, where the purified sewage passes into a stream which will scarcely at any time be brought to a drinkable condition, the presence of considerable number of bacteria in the final flow cannot be considered as an objectionable feature.

This is necessarily an interim report, and no doubt, as the experiments are continued, fresh light will be thrown on this interesting and important subject. The corporation of Leeds has just purchased a large estate of 1,890 acres for purposes of sewage disposal, and several years will be required before the great volume of sewage of the city and its dilutions can be conveyed to it. There will, therefore, be time to continue experiments, and to settle, with certainty, the best method of treatment for local conditions.

BACK LIGHTS FOR SIGNALS.*

By W. H. Lane.†

The great increase in the number of signals installed within recent years has demonstrated that the present standard colors for signal indications at night are in need of a radical change, as there are too many chances for a confusion of signals, and wrecks and derailments directly traceable to this fault are altogether too frequent. The use of the white light for a clear signal at night is the cause of most of the trouble. The substitution of a green light for white as a safety signal, and yellow for green as a caution indication, will go far towards eradicating this evil, and it may confidently be predicted that the majority of the railways in America will adopt these colors as standards in a few years.

The white light is also used as a back-light while the signal is at safety; whereas the danger position is shown on the back of the signal by a purple light. Not infrequently has the white back-light led to confusion, and it would be a step forward to eliminate this.

The liability for an engineman to become confused at night increases as the number of signal lights becomes greater, especially at large interlocking plants. With the front lights on the automatic interlocking, train order, and station signals, all of which must be strictly observed, there is already sufficient chance for confusion, and the back-lights on these signals should be so distinctive in color that they may be readily distinguished from the front lights.

Until within recent years, one of the serious problems which confronted signal engineers was to obtain a lamp that could be depended upon to burn all night under all conditions of the weather, and lights were displayed on the backs of signals in order that the towermen might have some means of knowing when the lights did not burn properly. Back lights thus came to be considered a necessary part of the signal, and they were displayed on all signals irrespective of their position in reference to the tower. With the advent of automatic signals no one thought of dispensing with these lights, but there does not seem to be any good argument for their use on automatic signals, especially on portions of a road remote from towers and stations. Their use on these signals has led to confusion. It seems, therefore, that the use of back lights on automatic signals may be more dangerous than their discontinuance would be. Some roads have already dispensed with the back-lights on all automatic signals and are well satisfied with the result.

There seems to be no reason for back-lights on those signals at interlocking plants, the front lights of which face the tower. In fact, signal lamps have reached such a state of perfection that if it were possible to have some guarantee that they would always receive proper attention, it would be a question whether back-lights should be used on any signals. But since the lampmen are not infallible, and since lamps do fail to burn properly on account of improper care or lack of inspection, it would scarcely be wise to discontinue the use of back-lights on all signals. But on those signals that require them we should eliminate the white light. The only color left is purple—the color now used as a back indication on a signal while it is at danger. This color is an ideal one for this purpose, for although it has not sufficient carrying capacity for use as a front light, it can be clearly distinguished at a distance of about ¼ mile, far enough for the needs of a back-light. The normal position of signals at interlocking plants is at danger, and the signal is at safety only for a few minutes preceding the arrival of a train and during its passage. Why, then, is it necessary to have any light displayed at the back of a signal while it is at safety? Let us suppose that a light be extinguished by the jar of the post occasioned by the signal being pulled to safety. In this case one of two conditions might arise: either the engineman of the approaching train would note the absence of a light where one is usually displayed, and treat the signal as a danger signal, or, uncertain of the previous existence of the light, or its location, he would pass the signal. Certainly in the first case no accident could happen; while in the second a train would pass a signal at safety. There does not seem to be any possible chance for an accident under either of these conditions, and no more probability of delay than in the present practice. By this arrangement of back-lights an indication of the improper working of the signal would also be given, as there would be a blue light displayed with the signal when at danger, and no light when at safety. The back spectacles should be so designed that the blue light will be covered at all times except when the blade is in the horizontal position. Such a spectacle would not require a blue glass, as there would be a blue glass in the back of the lamp.

*Abstract of a paper read at the meeting of the Railway Signaling Club at Atlantic City, N. J., Sept. 11.
†Supervisor of Mechanical Signals, Lehigh Valley R. R.

AUTOMATIC BLOCK-SIGNAL FAILURES DUE TO LIGHTNING.*

By H. D. Miles.†

There are two kinds of failures of automatic signals due to lightning, the failure of signals to clear and the consequent delay to traffic and the failure of signals to go to danger and the consequent imperiling of train movements. Three years ago the efforts of signal and railway companies were directed to the abolition of the latter evil, and I believe that I am within the truth in saying that it is possible now to prevent (except possibly in rare instances), lightning or any high potential foreign current causing the false display of clear signals. To-day the problem is how to avoid the other evil, namely, the setting to danger of automatic signals due to the action of lightning currents. The introduction of the carbon contact for relays and their use in combination with fuse wires has solved the first problem. A lightning arrester which will take care of the heavy discharges without opening the circuit, combined with the use of carbon to prevent the fusing of relay contacts by so much of the lightning current as may pass through the arrester, are the devices apparently which must be employed to solve the second problem. I believe that it is too early to say that the solution of the latter has been accomplished, nevertheless, the service rendered by the choke-coil lightning arrester encourages the belief that it or some better device will accomplish what is desired. The fuse wire is the chief agency of our present woes, and until it is dispensed with, the block signal maintainer is sure of an abundance of calls during the lightning season.

The only utility of fuse wires where carbon contacts are employed is to protect the relays and signal instruments from the heavy lightning currents; if these can be diverted to the ground before reaching the instruments, the problem will be solved. It is possible that the railways, through over-cautiousness, have made too free use of low capacity fuse wires. A great many one-ampere fuse wires are blown by currents which would not injure the instrument were no fuse wires used.

A brief history of the steps taken by the Michigan Central R. R. to overcome the difficulties mentioned may be of interest.

Previous to 1896 the Michigan Central had 31 miles of automatic blocking in service, a little more than half of which was controlled by track circuit. Practically no trouble was had with the track instrument system, as the line wires did not lead to ground or come into close proximity with grounded circuits. The signals controlled by track circuit were somewhat affected, but as the line wires were mostly confined to the over-lap section, and as few lightning storms passed over this territory during the two years in which these signals were in service prior to 1896, the difficulties experienced were so few that the lightning question was considered of little importance. During 1896, 110 miles of the track circuit system of automatic signals were installed, but were put in service so late in the year that it was not until 1897 that the importance of the lightning problem was realised. On this installation, indicators were used at all main track switches and the consequent long lines of overhead wire, necessitated by the introduction of the indicators, aggravated the difficulties.

The first arrester used to prevent the fusing of contacts and the burning of magnet coils was the old style sawteeth type, the ground plate being connected with the relay wires which led to the rails of the track. The lightning currents which fused the relay points did so on account of the path afforded through the track relay, track wires and rails to ground and as the air gap between the contact strips and ground plate of the arrester was less than that between the armature and magnet coils of the track relay, it was naturally inferred that high potential currents would take the path of least resistance and thus avoid fusing the contact springs. The service rendered by this form of arrester, even when combined with fuse wire protection, did not prevent the fusing of platinum contact points, and consequently these arresters were abandoned in 1898 and carbon contact strips and ground plate arresters having a high resistance substance making contact between the ground plate and the contact strips, which were connected to the track and line wires, were substituted. One-ampere fuse wires for track and two-ampere fuse wires for line circuits were used in connection with these arresters. The ground plates in this case were connected with galvanized iron pipe driven in the ground, experience having proved that the use of the rails as grounds increased the number of signal failures.

To further guard against the danger of fused points, carbon points were used in relays to control the line circuits and the Buchanan back-contact shunt was applied where track circuits were controlled, in order to shunt the track battery should the front contact fuse. It was considered impracticable at that time to use contact points made of carbon for controlling the low potential track currents, on account of the high resistance of that substance. Since these alterations were made there has not been a single case of a signal being held clear by fused contacts, although many instances have occurred of the signals being held at danger on account of blown fuse wires. From Jan. 1 to Aug. 20, 1900, 36% of the failures of signals to clear were caused by lightning, and nearly all of these failures were due to blown fuse wires.

In 1899 five miles of the semaphore type of automatic signals were installed, carbon contacts being used to control all circuits and 2½-ampere fuse wires and choke coil lightning arresters being used in all line circuits, no safeguards other than carbon contacts being provided for the track circuits. In this instance, the arresters, instead of being in the relay boxes, were located in cast iron boxes on the telegraph poles. Two types of choke coil arresters are employed. In one the coil of wire is wound on a hard rubber spool or cylinder, in the other the wire is wound on a porcelain spool having a hollow center in which is inserted a soft iron core. The Hall Signal Co. claims, from a series of tests made with a high potential current, that the simple choke coil arrester discharged about 54% of the current to ground, while the iron coil discharged 95% of the current to ground. I believe the theory is that the iron core offers an additional retarding effect to the flow of the current, thus causing it to discharge more freely to the ground plate.

On this latter section of blocking, no signal failures have occurred due to lightning since this installation was completed, although lightning troubles have been experienced both east and west of this section of blocking, and the porcelain spools of three of the arresters have been shattered by lightning. It is too soon to judge of the efficiency of this method of protection, but as there are line wires throughout each block and several lightning storms have passed over this section, the inference to be drawn encourages a fair hope for the future.

On 15 miles of double track blocking now about to be installed on the Canada division, the semaphore type of signal will be used and distant signals will be provided instead of overlaps. Polarized relays instead of line wire will be employed for controlling the distant signals, thus reducing the field for lightning troubles as far as possible. Where line wire is used for indicators and for controlling slots on interlocking signals, the choke coil arresters with iron core centers will be used, but no fuse wires will be employed either in the track or line circuits. Carbon points will be depended upon to prevent fused contacts due to light discharges, and the choke coils will be depended upon to take care of the heavy discharges. The majority of the blocks are two miles in length, and each two-mile block is subdivided into four sections, consequently there are numerous cases where the relay of one section controls the battery of the next section.

The use of carbon contacts for controlling track batteries in this way has been found satisfactory on the five miles of blocking installed last year. The average resistance of carbon contacts, established by several tests on instruments of two years service, was ⅛ ohm. The average resistance of one-ampere fuse wires which were in service but a few days, based on several tests, was 1-5 ohm, therefore by the substitution of the carbon contact for the fuse wire, only 2-15 ohm resistance was added to the circuit, and this is far from a prohibitive resistance, even when the ballast is against the rails, as is the case on the Michigan Central R. R., and this difference in resistance is considerably reduced as the length of service of the fuse wire is increased.

Greater effort will be made to secure good ground connections than has been made in the past. A great many failures of lightning arresters to properly perform their function may be attributed to imperfect ground connections, therefore no reasonable expense should be spared to secure good "grounds." It is proposed to dig holes deep enough to reach permanently damp earth, to imbed copper plates in crushed charcoal at the bottom of such holes and to use copper wires to make the connections between the copper plates and the arresters. It is antici-

*Abstract of a paper read at the meeting of the Railway Signaling Club at Atlantic City, N. J., Sept. 11.
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pated that on this installation damp earth will be found at a reasonable depth.

It will be an easy matter to provide fuse wires if their service is found necessary in order to protect the relay and indicator coils from frequent injury, but an occasional damage to such instruments will be considered of less importance than the frequent blowing of fuse wires.

THE TRADE OF TIENTSIN AND THE CONTROL OF THE PEIHO RIVER.

Few people not directly interested in matters Oriental ever heard of Tientsin three months ago. At the present time it is familiar to every one. There has recently come into our hands a report on the trade of Tientsin, made by the British consul at that point so recently as July of the present year, and some interesting particulars are given concerning the commerce of the city, which has since that time been the scene of siege, capture, carnage, loot, and conflagration.

The trade of Tientsin has steadily grown from 28 million Haikwan taels in 1888 to 77.6 million Haikwan taels in 1899, or, in round numbers, from 19 million dollars to 52 million dollars. Practically the city supplies with foreign goods all that part of China north of the Yellow River, extending as far west as Thibet, and including also a part of Kan Su, south of the river. It is also the key to the markets of East Turkestan and Thibet, and foreign merchants in Tientsin, says the consul, have their agents buying produce for them in the extreme west of Kan Su, distant over 1,200 miles inland, a journey so great that, with the primitive means of communication existing, some of these men may very likely still be in ignorance of the events in China which have absorbed the attention of the world for months past.

The history of the China railway, due, as the consul says, to the energy and enterprise of Mr. C. W. Kinder, M. Am. Soc. C. E., more than to any other man, is briefly traced, and it is stated that the system had an extent of about 550 miles when it was turned over to a Belgian syndicate, in January of this year. The financial results of the railway's working have been excellent. The operating expenses are said to average only about 46% of the gross receipts. During the first year 2,174,808 passengers were carried, of whom only 36,843 were first-class passengers. The rates of fare are low—1 cent per mile for first class, and half that for second class.

The trade of Tientsin is threatened, however, by the condition of the Peiho River. Only one steamer in 1899 ventured to cross the bar and ascend to Tientsin, whereas a few years ago all vessels did so. Goods are at present brought up to Tientsin in lighters, and in consequence freight rates are high. The silting up of the channel is ascribed to the drawing off of water from the Peiho by canals to the Peitang, thus lessening the volume of the current and the scouring effect. To counteract this effect, locks have been constructed in the canals under direction of Mr. de Linde, a Danish engineer.

It is interesting to note that the construction of the canals which have caused the trouble was undertaken by Li Hung Chang to relieve the floods in the Peiho, by carrying off a portion of the flood waters to the Pietang. Some improvement did result, so far as the height of the floods is concerned, but the navigation of the river has suffered, and just north of the city a large tract of 4,500 acres, formerly under cultivation, has had to be abandoned on account of the flooding. It is stated that the foreign advisers of Li Hung Chang urged the straightening and improving of the lower channel of the Peiho River to give relief from the floods instead of the cutting of the canals. Chinese public opinion was so strongly in favor of the canal scheme, however, that it was finally adopted.

There is a curious reminder in this story of the long standing controversy over the problem of Mississippi control in this country. Here, also, it is the experts who have urged the confinement of the river to its main channel, and it is the popular party which has favored the lateral outlet plan, which was tried with such unfortunate results in China.

The report concludes with the following reference to the troubles which were then impending, but whose magnitude was evidently by no means appreciated:

Brigandage generally exists in autumn and winter in the neighborhood of the eastern extremity of the Great Wall where three separate jurisdictions meet, and facilitate the escape of criminals from capture. Last year the brigands had become so much emboldened by the leniency shown towards them by the authorities that from August to October the whole country in that neighborhood was terrorized by them, and eventually 10,000 troops, including artillery, were required to suppress them.

The number of the brigands certainly did not exceed 1,200 men, and very probably was not more than 400, but they were armed with Mannlicher, Mauser, and Winchester rifles, and a plentiful supply of ammunition. Not content with plundering travelers, they held small towns up to ransom, demanding in one case as much as $50,000, and did not shrink from engaging the troops who were first sent to suppress them, but were worse armed than they. Eventually the leaders were captured and executed, and at least 100 of their followers were put to death. The institution of trained bands in the villages under the supervision of the military officers did much to effect this result, and the villagers were thereby encouraged to denounce the robbers when they took refuge among them.

While troops from the south of the province were engaged in putting down brigandage in the northeast, a movement against Christian, and more especially Roman Catholic converts, was spreading in the south of Chihli, which subsequently occasioned the despatch of some 3,000 to 4,000 troops from this neighborhood. A sect known by foreigners as the "Boxers" from the gymnastic drill which they cultivated had spread from the neighboring province of Shantung into Chihli, wrecking chapels and the houses of converts, and demanding ransom for prisoners and their property. The passion which prevails throughout China for secret societies led to adherents joining the sect in great numbers, and to the leaders being invited to open lodges in scores of other villages. The drill and spells used by the Boxers were supposed to secure invulnerability, and undoubtedly this belief was shared in not only by villagers, but by many officials and by Boxers themselves. Instances of men allowing this invulnerability to be tested in cold blood, with fatal results, have been vouched for to me by officials; but the ill success of the experiments did not shake the faith of the people, and even the sight of men being shot down when in conflict with the troops has not had any effect.

It is difficult to understand the precise object which the Boxers have in view. They certainly are considered to be actuated by patriotic motives and in some way to be opposing foreign encroachments on their country. But they are not armed with firearms, and do not seem to be making any effort to procure arms. Considerable sympathy is felt for them by a powerful section of the official class, and though the sect was prohibited by name in 1808 by Imperial Edict, and the local authorities were ordered to extirpate all its adherents, on account of its disloyal teaching, no serious effort has been made to enforce the provisions of this Ediot against them in the present day.

Several of their leaders have been Taoist priests, which may account for their claim to possess supernatural gifts. But their adherents are to be found among villagers, shopkeepers, servants, and soldiers without any distinction of class. Hitherto their hostility, in this province at any rate, has been directed solely against Christian converts, though the inscription on their banners runs "Exalt Ch'ing (the present dynasty), extirpate foreigners." The spread of the sect is undoubtedly due in a large measure to the absence of rain, which is ascribed to the evil acts of foreigners, and owing to which the country people are without occupation as they have been unable to get any seed into the ground for spring crops. There is reason to hope that the fall of rain may send the people to their farms and prevent the movement assuming any serious proportions.

ANNUAL MEETING OF THE CENTRAL STATES WATER-WORKS ASSOCIATION.

The fourth annual meeting of the association was held at Columbus, O., Sept. 4 to 6. After the usual preliminaries, Mr. C. W. Wiles, of Delaware, O., President of the association, read his address. He ascribed the rapid growth of the association largely to the aid given by the associate members and by the daily and technical press. The report of the treasurer showed a balance in hand of $130. The constitution was amended by adding Tennessee and Iowa to the section covered by the association, which previously embraced Ohio, Indiana, Kentucky, Illinois, Michigan, West Virginia and Western Pennsylvania.

A committee was appointed to work with committees from other societies to secure legislation against electrolysis. Its chairman is Mr. F. A. W. Davis, of Indianapolis. It was also voted to refer to the executive committee the matter of printing papers in advance of the conventions. A number of members were in favor of such advance publication, in order to secure more discussion. Not even the names and authors of papers were announced on the program this year.

Uniform Municipal Accounts and Reports.

By M. N. Baker, New York City.

This paper opened with the statement that after an examination of thousands of printed and written reports the author was convinced that "the financial accounts and general records of most of the water-works of the United States are in a deplorable condition." State supervision of municipal accounts and the adoption of uniform schedules for summaries of statistics in annual reports were suggested as steps towards improving these conditions. It was also suggested that the Central States Water-Works Association appoint a committee to confer with similar committees from other societies to forward the general scheme of uniform accounts in all branches of municipal activity.

In discussing this paper, Mr. J. J. Pater, of Hamilton, O., said a bill for uniform accounts and state audit was introduced in the last session of the Ohio legislature. Mr. Wm. A. Veach said there was no question as to lack of uniformity. He moved that the President appoint a committee of three to carry out the suggestions in the paper. This motion was carried, and the President appointed as that committee Messrs. W. A. Veach, of Newark, O.; W. B. Mitchell, of Piqua, O., and Fred J. Catlin, of Flint, Mich.

Stone Masonry for Water-Works Plants.

By Chas. A. Hague, M. Am. Soc. M. E., New York City.

The author said he preferred American Portland cement to the foreign brands. He urged the importance of seeing that contractors make themselves thoroughly familiar with the specifications under which they are working, instead of following preconceived notions. The paper dealt, for the most part, with the methods to be employed in securing water-tight walls. Where the work is complicated or its quality is of far more importance than its cost, it is advisable to have it, or parts of it, done by day labor, instead of by contract. There was no discussion on this paper, except a remark by Mr. Jerry O'Shaughnessy, of Columbus, O., to the effect that no one would dissent from the points made by the author.

The Causes of Tastes and Odors in City Water.

By S. J. Hoggson, New Haven, Conn.

The burden of this paper was that a great mistake has been made as to the causes of tastes and odors in water. In 1856, or thereabouts, a professor in Yale University:

made a mistake by saying that this water trouble was caused by a conferva of the algae species, or the submerged plant commonly known as the fresh water sponge. This mistake was quite natural, as the water was examined during its sickness and the gelatinous substance of this plant had absorbed the fish-like odor of the water (note this—Ed.) and it held it more tenaciously than other plants. . . . . This fresh water "what is it" has been held up to screen every complaint for the last 40 years.

The author did not state his views as to the causes of tastes and odors in water very clearly, further than to indicate his belief that they are due to gases generated in water when it attains "a temperature intermediate between that of ice passing to water and water passing to steam." Such gases are dissolved by the water and become a constituent part of it, so that "filtering, boiling, freezing or even distilling has little (if any) effect upon it." According to the author, state and local boards of health have misconceived this whole question, as will be apparent from the following quotation:

In the opinion of the writer, the best way to put out a fire is to prevent the first smoke of the match. In my own case I would rather prevent the other fellow from pulling the trigger than to have a whole state board of health probe for the ball.

The exact extent of the water "sickness" which has been so misconceived by scientists and others all these years is stated by the author as follows: Of 3,800 water-works in the United States and Canada in 1899

there are 957 of them who sell diseased water during the summer months. There are 193 water systems which now have the disease in a milder form, but will have it in force in the near future.*

The three papers abstracted above were the only ones that had been received by the officers of the association up to the close of the business sessions on the third day of the convention.

The election of officers for the ensuing year followed, and resulted in the choice of the following:

President, Mr. Harvey Cockel, Columbus, O.; Vice-Presidents, Messrs. Joseph J. Pater, Hamilton, O.; Quince Walling, Muncie, Ind.; Fred. Catlin, Flint, Mich.; Wm. H. Glore, Covington, Ky., and Clark Howles, Charleston, W. Va.; Secretary, Wm. Allen Veach, Newark, O.; Treasurer, Mr. Chas. E. Rowe, Dayton, O.; Executive Committee, Messrs. Jerry O'Shaughnessy, Columbus, O.; Geo. Hornung, Newport, Ky., and C. W. Wiles, Delaware, O.; Finance Committee, re-elected; Editor of Proceedings, Mr. Lehman B. Holt, Cleveland, O. Evansville, Ind., was decided upon as the place in which to hold the next annual convention.

After the business session was concluded the members listened to a paper by Mr. C. Monjeau, Middletown, O.,

*For the benefit of these 1,150 plants, we will state that we have learned from a source outside the paper in question that Mr. Hoggson, who, by the way, is a "synthetic chemist," says he has a process for preventing tastes and odors so simple that it can be applied by anyone who can row a boat.

entitled "On What Nature Exacts as Due Disposal of Refuse," and following this the final adjournment was taken.

During their stay in Columbus the members were given an exhibition by the Columbus Fire Department and visits were made to the various pumping stations about the city.

THE CANADIAN EXCURSION OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.

(Concluded from page 169.)

The Thetford Asbestos Mines.

To the mineralogist, asbestos is a fibrous variety of the mineral hornblende; but to the practical miner and to the manufacturer of asbestos products it is a far different material, being a fibrous variety of serpentine rock. The mineralogist calls the miner's "fibrous serpentine," "chrysolite," and the miner retaliates by classing the mineralogist's "fibrous hornblende" as "bastard asbestos" when he markets that mineral. Since "fibrous hornblende" has very little economic value while "fibrous serpentine" has during late years become an article of great commercial importance, the miner's nomenclature, however unwarranted it may be scientifically, has the important essential of general adoption and use to support it. For all practical purposes, therefore, fibrous serpentine is asbestos and fibrous hornblende is not.

Inasmuch as asbestos is fibrous serpentine, every deposit of the latter is a possible mining ground, and, as a matter of fact, there are very few exposures of serpentine rock which do not display more or less material of the fibrous variety. Somewhat strangely, however, only small areas of serpentine rock in only two countries, Italy and Canada, are important producers of commercial asbestos. For this reason the prospect of an ocular study of practical asbestos mining operations at one of the richest deposits of this material in the world was a treat which the mining engineers and geologists of the party contemplated with unusual interest. Unfortunately the previous entertainments of the day had made the time remaining so short that only the briefest examination of the mineral deposits and of the mining operations being conducted was possible. However, the mines were so easily accessible to view and the mining operations so simple that a short time sufficed to permit a general knowledge of the work to be obtained by those who were energetic enough to make the necessary effort.

It will aid to a better understanding of asbestos mining and of the Thetford asbestos deposits, perhaps, if we refer briefly first to the general character of the asbestos bearing serpentine rock outcrops of Canada in a general way. Broadly speaking, the productive area of asbestos serpentine in Canada is confined to a very small portion of the belt of this rock which extends from the Vermont line northeast to some distance beyond the Chaudiere River in the province of Quebec. Not all of this rock belt by any means is productive in asbestos; indeed, the productive areas are limited to four small districts located respectively in the vicinity of Thetford, of Black Lake and of Broughton stations on the Quebec Central Ry., and at Danville, on the Grand Trunk Ry. The deposits at Thetford were the first to be developed in 1877-9. Previous to this time practically all of the world's supply of asbestos came from Italy. The superiority of the Canadian mineral over the Italian soon placed it ahead of the latter in the market, and now Italy imports far more asbestos from Canadian mines than it exports to the whole world. The superiority of the Canadian asbestos over the Italian lies largely in the ease with which its fibers can be separated. Altogether the Quebec mines produced about 23,000 tons of asbestos in 1899, which was probably not far short of 85% of the total production of the world. It may be interesting to notice that the asbestos production of the United States for 1899 was about 900 tons.

In the Canadian deposits the asbestos forms irregular veins in the serpentine, varying from mere threads to from 4 ins. to 6 ins. in thickness, but the greater part of the highest grade is taken from veins which do not exceed 1½ ins. to 2 ins. in thickness. The fiber nearly always lies at right angles to the walls of the veins. The normal color of the asbestos in the veins is whitish, greenish or yellowish, but occasionally the mineral is discolored by iron oxide, particularly in the surface veins. The veins themselves sometimes contain foreign matter which lessens the value of the material, both because it cuts the fiber and because it is expensive to separate from the asbestos. Formerly the very fine veins were regarded as valueless and were not worked, but in 1896-7 experiments made at the Danville mines showed that the material in these fine veins, when crushed, made an excellent substitute for plaster, and the new article has since been put on the market under the name of asbestic and has become largely used, some 7,700 tons being manufactured in Canada in 1899. Taken all in all, the Thetford mines probably produce asbestos which is more free from foreign matter than that from any of the other districts, besides producing a greater quantity of the mineral than any of the other Canadian deposits.

The method of mining asbestos-bearing rock and of separating the mineral from the barren rock is in a general way the same in all of the Canadian mines, so that a description of the plant and operations witnessed at the works of the Bell's Asbestos Co., Ltd., at Thetford, by the members of the Institute will answer for all the others except in minor details. It should be noted before proceeding, however, that while the visit of the party was limited because of lack of time to the works of the company just named the courtesies of the occasion were extended jointly by this company, the King Bros. Co., and Johnson's Asbestos Co., all of which operate in this district. The mining is carried on in open quarries, the quarry pit at Bell's mine being several acres in area and about 150 ft. deep. The serpentine is drilled and blasted and is conveyed to the surface by cableways and derricks. The first task is the separation of the asbestos-bearing rock from the barren rock and this is done by hand picking. The portions containing asbestos are then conveyed to the cobbing house, where old men and boys knock off the long fibered asbestos from the serpentine. Generally cobbing is limited to veins from ¾-in. thick upward, the separation of the asbestos carried by the thinner veins being done mechanically.

The mechanical separating process is a simple one. From the cobbing room the rock is deposited in chutes leading to a battery of rock breakers below. At Bell's mines gyratory breakers of the Gates' type were employed and from them the coarser fragments pass to a set of crushing rolls. From these rolls the crushed rock passes onto traveling belt picking tables, where boys standing alongside pick the fragments of barren rock off the belt and throw them to one side. The mineral-bearing fragments pass from the picking tables to cyclone pulverizers in which the final crushing is performed and where a current of air separates the light asbestos fiber from the heavier rock dust. At various points between these crushing and picking operations the material is screened, and finally the asbestos fiber is screened from the fine dust and finely broken fiber. The operation is a continuous one, the rock passing from the top floor downward through the various processes until the final product—commercial asbestos—is turned out at the ground floor. Except for the work of the boys at the picking tables the operation is a mechanical one throughout.

The separated asbestos is divided into three grades for the market. The first grade comprises the long-fibered material which is separated by cobbing. The two other grades are similarly determined according to length of fiber, color and freedom from foreign matter. The material not good enough to be included in any of the three commercial grades, but which contains fiber, is called "waste" and really constitutes a fourth grade. The sorted asbestos is packed in bags of 100 lbs. capacity for the market. At the Thetford mines about two tons of commercial asbestos is obtained from every 100 tons of rock which is crushed. Altogether about 600 men are employed in the mining operations of the three companies working the deposits at Thetford.

At the conclusion of their hasty round of the mines and works, the members of the party were assembled to partake of the excellent dinner provided by their hosts of Thetford previous to speeding them on the remainder of their day's journey to Quebec. Mr. George R. Smith, Manager of Bell's Asbestos Co., acting as the representative of the three companies, welcomed the guests in a neat speech, encouraging their exertions to dispose of the good things which heaped the tables before them. From dinner the party proceeded to the train, which landed the company, tired but enthusiastic, in Quebec at 11 o'clock. Here were found the western members of the Institute and the Canadian party who had previously arrived and who had provided an English supper of sandwiches and ale in the grill room of the Chateau Frontenac, where a number of the city's officials and the Canadian Minister of Mining welcomed the American guests with brief addresses.

Quebec.

To attempt to contribute here to the word pictures which decorate the pages of the novelist and historian of the quaint old capital of Canada would be presumptuous. It is sufficient to say that the laggards were few in number which the bright sunshine of an almost perfect morning greeted on the second day of the trip. Except for a trolley car excursion around the city, the attendance on which was left optional, the regular programme left the guests free to seek pleasure and instruction in their own way; the citadel and fortifications, the Heights of Abraham, the convents and churches, the winding streets and quaint houses of the Lower Town, and the walk along Dufferin Terrace, with its magnificent prospect of the St. Lawrence and the rolling hills and blue mountains to the south and east, each drew its quota of visitors. In the afternoon the members assembled for a steamboat trip on the St. Lawrence River. The Government steamer "Druid" was placed at the disposal of the guests for this trip by the Canadian Minister of Marine and Fisheries, and visits were made to Montmorenci Falls and to various points of historical and scenic interest along the harbor front. At 8 o'clock in the evening the party boarded the special excursion train which had now been increased to eight cars, including a dining, baggage and servants' sleeping cars and five Pullman sleeping cars for the members. The route taken was over the Intercolonial Ry. to Sydney, Cape Breton, where the train arrived on the forenoon of Aug. 21.

Sydney.

The town of Sydney, Cape Breton, derives its chief interest because of the fact that its location has made it the center of the sudden industrial activity which has resulted from the widely heralded plans of Mr. Henry M. Whitney, of Boston, Mass., to establish in Nova Scotia a coal mining, coke making and steel manufacturing industry of mammoth proportions to utilize the rich deposits of coal and iron ore of northern Cape Breton and Newfoundland. Outwardly the place presents the usual upset appearance of a staid rural town engaged in the chaotic struggle of adapting itself to a sudden increase of capital and population. As a result of the industrial activity it is stated that the assessed valuation of the town has increased nearly 200% within a year and that the population has materially increased correspondingly, with a prospect of much larger growth when the steel works and coke plant are put in operation. To accommodate this growth it is planned by the city council to expend some $200,000 in the near future in necessary municipal improvements. Of this total about $75,000 will be expended in enlarging the water works and the same amount in building a sewerage system. $10,000 will be spent for sidewalks and street extensions, $12,500 in improving the fire department, and $27,500 for additional school facilities. The municipal affairs of the town are managed by a Mayor and Municipal Council consisting at present of seven members. The town is located on the northern arm of Sydney Harbor, which has a depth of water sufficient to accommodate ocean vessels of large size, and it forms the northern terminus of the Intercolonial Ry., and is connected with Louisburg by the Sydney & Louisburg Ry.

The programme of sightseeing provided for the Institute's party at Cape Breton included a visit to the new steel plant of the Dominion Iron & Steel Co., now under construction at Sydney and another to the mines and collieries of the Dominion Coal Co., with several side excursions in the way of purely pleasure trips. There was also provided an optional excursion to Newfoundland and the Belle Isle iron mines from which the new steel works are to draw their supply of iron ore. About 30 members of the party altogether took the Newfoundland trip.

Dominion Iron & Steel Co.'s Plant.

The work of the Dominion Iron & Steel Co., of which Mr. Henry M. Whitney, of Boston, Mass., is the President and leading spirit, contemplates not only the erection of a modern steel plant at Sydney, but the manufacture of coke from the coal mines of the affiliated Dominion Coal Co., the mining of iron ore at Belle Isle, Newfoundland, 400 miles by water from Sydney, and the opening of limestone quarries at Georges River, Cape Breton. Each of these co-ordinate enterprises will be described in its proper place further on. Here attention will be confined for the present to the coke plant and the steel plant at Sydney.

Coke Plant.—The new coke plant of the Dominion Iron & Steel Co. will consist when completed of eight batteries, each containing 50 Otto-Hoffman by-product coke ovens, or, altogether, of 400 ovens, the total capacity of which will be 1,600 tons of coke per day. The gas from these ovens will be utilized in the company's open-hearth furnaces, while the other by-products, ammonia and coal tar, will be marketed. The plant is substantially a duplicate of the coke plant of the New England Gas & Coke Co., built by Mr. Whitney at Everett, a suburb of Boston, Mass., which has been in operation for some months, using the same Cape Breton coal for the raw material which will be used at the Sydney plant. As proof of the certain success of coke making from its Cape Breton high sulphur coals, the new company points to the success of the Everett plant and to the fact that the Nova Scotia Steel Co. has used coke made from the same coal in its Ferrona furnaces for a number of years. In this connection it will be interesting to quote from some recent analyses of washed coal slack from the Cape Breton mines and of the coke made therefrom by the Nova Scotia Steel Co.:

	Washed coal		Coke	
Name of Seam.	Ash.	Sulph.	Ash.	Sulph.
Hub	4.37	2.38	11.2	1.34
Phalen	7.05	2.87	11.3	2.13
Harbor	5.5	3.12	12.8	2.79

Regarding the expectations of the company in the shape of profitable by-products from its coke ovens, no better illustration can be presented perhaps than the following brief quotation from a pamphlet which it has widely distributed in Canada:

At Everett the New England Gas & Coke Co. sell their sulphate of ammonia at 2½ cts. per lb., and get about 30 lbs. from a ton of Cape Breton coal in the process of coking. Assuming that only 28 lbs. of sulphate of ammonia will be obtained at Sydney, and that the selling price will be only 1¾ cts. instead of 2½ cts. per lb. it will yield 49 cts. per ton of coal. The by-product ovens at Everett also obtain from a ton of Cape Breton coal about 12½ gallons of tar, which is sold at 2 cts. per gallon, and about 5,000 cu. ft. of gas which is sold at 20 cts. per thousand. At Sydney the surplus gas will be used in the steel mill and it will be fair to estimate its value at the cost of natural gas in the most prolific natural gas districts of the United States, or 5 cts. per 1,000 ft. This will give the steel mill as cheap fuel as if it were located in a natural gas district. It is calculated that the quantity of gas produced at Sydney will be somewhat less than at Everett as the coke will be treated somewhat differently to suit the blast furnaces, but it will not be less than 3,000 ft., which at 5 cts. per 1,000 ft. will be 15 cts. per ton of coal. The quantity of tar obtained will be about 10 gallons per ton of coal, which at 1 ct. per gallon, half the price obtained in Boston, would give 10 cts. per ton of coal. Thus the value of the ammonia, gas and tar obtained from each

...n of coal will be not less than 74 cts., while the cost of manufacturing the coke and by-products will only be about 40 cts.

These estimates, if they prove reliable, certainly present very favorable figures. The construction and operation of the Otto-Hoffman coke ovens are pretty well known, and need not be described here. At the time the visit to the plant was made the several batteries of ovens were in various stages of construction, some of them being practically completed and others only just begun. The construction, as far as could be seen, bore every evidence of excellent workmanship and materials. The contract price of the plant is not known, but the preliminary estimates of the company placed it at $1,250,000, or a little over $3,... per oven, which is certainly a low figure.

Steel Plant.—The site of the steel plant is directly on Sydney Harbor and comprises 460 acres of land and some 340 acres of water. In a future issue we hope to give complete details of the plant and its equipment so that here only its more general features will be mentioned. Briefly summarized the plant will comprise blast furnaces and open-hearth furnaces having a capacity of 1,400 tons of steel per day, blooming mills, general machine shop and foundry, unloading piers and wharves, and all necessary subsidiary buildings. The only part of the plant now completed and in operation is the machine shop and foundry, which is 60 × 480 ft. in plan. The blast furnace plant, consisting of four 350-ton furnaces, is next furthest advanced; indeed, the company expresses the hope of putting one of the furnaces in blast early this fall—a very doubtful possibility as the work appeared at the time it was visited. The other main buildings had not advanced beyond the foundation work in any case. It may be noted in passing that this foundation work has been of a very heavy character and that concrete has been used almost exclusively.

Practically all of the construction materials and machinery have been imported from the United States, almost none of it being obtainable in the Province. Skilled labor has also come from the States and the ordinary laborers are for the most part inhabitants of Newfoundland. The contractors for the blast furnaces are Riter & Conley, of Pittsburg, Pa., and the blowing engines are to be furnished by the Edw. P. Allis Works, of Milwaukee. The fire-brick and cement used are also imported, but much of the general structural steel work is being furnished by the Dominion Bridge Co.

In addition to the steel making plant proper, the works when completed will comprise extensive railway yards, water-supply and drainage systems, electric lighting system, boarding and lodging houses for employes, hospitals, offices, storage houses, yards, etc. The water supply will come from Sydney River about 5 miles from the works, where a dam is being constructed and will amount to 3,000,000 gallons per day. About 8 miles of mains will be included in the distribution system. The general layout of the works is along a comparatively narrow area of ground about two miles long, following the harbor front. At one end are the shipping piers, followed by the blast furnace plant, open-hearth furnaces, blooming mill, machine shop and coke plant. Nearly 20 miles of railway track will be required to connect the various parts of the plant and yards.

The manager of the Dominion Iron & Steel Co., of which Mr. Henry M. Whitney is President, is Mr. A. J. Moxham, Assoc. M. Am. Soc. C. E., who will be remembered as having been President of the Lorain Steel Co., of Lorain, O., previous to its absorption by the Federal Steel Co., and also as having been associated for many years with Mr. Tom L. Johnson in the Johnson Co., with extensive works at Johnstown, Pa., for the manufacture of street railway rails, switches and track supplies. In behalf of Mr. Whitney and the company, Mr. Moxham formally welcomed the visitors at a luncheon spread in one of the large employee's dining halls. After luncheon the visit to the works, which had begun at the coke plant, was continued by a visit to the blast furnace plant and shipping piers, the party returning to Sydney at 4.15 o'clock in the afternoon.

In the evening a joint meeting of the American Institute of Mining Engineers, the Canadian Mining Institute and the Mining Society of Nova Scotia was held at the Sydney Rink. The visitors were welcomed to Sydney in a short address by Mayor Crowe, to which responses were made by Mr. James Douglass, President of the American Institute; Mr. Chas. Fergie, President of the Canadian Institute; Secretary R. W. Raymond and others. It was also announced that the programme of the next day would include an excursion to the shipping piers, collieries and coal-washing plant of the Dominion Coal Co., and to the ruins of old Louisburg. Previous to resuming the record of the excursion, however, a brief description of the Belle Isle iron ore mines, which were visited by some of the party later during the excursion, will be given.

Belle Isle Iron Mines.

Belle Isle, or Bell Island as it is more generally named by the atlases, lies off the northern coast of Newfoundland, about 400 miles by water from Sydney, and is about 8 miles long and 2 miles wide. It derives particular importance from the fact that it will provide the principal supply of ore for the works of the Dominion Iron & Steel Co. There are in all five beds of ore exposed in the cliffs upon the northern side of the island, but three of these extend over so small an area and are so thin that they are of little commercial value. The other two are known as the upper and lower beds; the former, which is estimated to contain 6,000,000 tons, being still owned by the Nova Scotia Steel Co., which sold the lower bed containing 28,000,000 tons to the Dominion Iron & Steel Co. for $1,000,000. Both beds have the same peculiar formation, a closely packed mass of rectangular blocks of red hematite varying in size from 1½ × 2 × ½ ins. to blocks as large as fire bricks. The bulk of the mass consists of blocks about 2 × 2 × 4 ins. The lines of cleavage between the blocks are strongly marked and it is only necessary to shake them apart by light blasts to put the ore in shape to be handled by shovels. The lower bed, which is owned by the Dominion Iron & Steel Co., outcrops on the ocean cliff for a length along the shore line of about 3½ miles. It is expected that the mining can be done by open cut for a distance of 200 ft. into the cliff for this entire length of exposure, giving about 3,000,000 tons of ore. When this is mined out the work will be carried underground with natural drainage, and when the shore deposits are wholly exhausted it is confidently expected that the veins can be followed under the sea as are the coal seams of the Dominion Coal Co. at present.

The ore is shipped from the south side of the island, which is sheltered from the northerly winds and where the water is deep and free from rocks and shoals. The bay is navigable for from eight to nine months of the year. The mine is connected with a loading pier extending out into the bay by a double track tramway of 2 ft. gage, operated by an endless wire rope. The pier as it now stands is 90 ft. high and is constructed of southern pine trestle-work resting on piles and protected by cribs filled with stone. There are ten pockets of 200 tons capacity, each at a height sufficient to discharge into vessels by gravity. The cars from the mine run out onto this pier and dump automatically into the pockets. It is stated that with the present facilities 2,500 tons of ore can be shipped daily from this pier.

At the present time Bell Island ore is being shipped regularly to the furnaces of the Nova Scotia Steel Co., and some shipments have also been made for export. According to the estimates made by the Dominion Iron & Steel Co., the cost of mining the ore and loading it on the vessels is from 25 to 30 cts. per ton. These figures are said to be based upon the shipments of 600,000 tons made so far, and it has to be remembered, therefore, that they relate to open mining on the surface outcrops. When the mining is carried underground and ultimately under the sea, should this prove practicable, the cost will of course materially increase over these figures.

While the Dominion Iron & Steel Co. will depend for the bulk of its ore supply upon the Bell Island mines, it also owns mines at Santiago, Cuba, from which it can draw ore. Its promoters, moreover, do not hesitate to assert that, with the newly opened Canadian Canal system giving through water transportation to Sydney, ore from the Lake Superior mines can be laid down at the furnaces at a cost low enough to permit the works to compete in price of pig iron and steel for foreign consumption with American works. It will be interesting to note at this point that the company estimates that by using ore exclusively from the Bell Island mines, by manufacturing its own coke from coal supplied by its own mines, it can turn out pig iron at $5.50 per ton and steel billets for about $10.50 per ton. The pig iron cost in detail is itemized as follows:

1.8 tons of ore	$1.80
1.25 tons of coke	1.80
0.75 ton of limestone	.40
Labor, repairs and incidentals	1.50
Total cost of pig iron per ton	$5.50

These figures do not take into account the bounty on pig iron production which the Canadian Government has recently extended to 1907 on a sliding scale and which now amounts to about $3 per ton.

Dominion Coal Co.

The excursion provided by the Institute party's Sydney hosts for Aug. 22 comprised visits to the shipping piers, collieries and coal-washed plant of the Dominion Coal Co., with a side trip by water to the ruins of old Louisburg. Before describing the particular works visited in detail it will aid to a somewhat clearer understanding of the developments which have been undertaken if a brief summary is given first of the several coal deposits of Nova Scotia.

Nova Scotia Coal Deposits.—The coal fields of Nova Scotia are, broadly speaking, three in number and are known respectively as the Cape Breton, the Pictou and the Cumberland fields. The Cape Breton fields comprise four large and comparatively distinct areas, of which only one, the Sydney field, is now worked; this alone will be described further. The area of the Sydney coal fields has been estimated as 200 square miles, to which must be added an immense but unknown area of submarine seams. The total number of seams in the productive measures is 24, of which six are 3 ft. or upwards in thickness. The seams are very regular, have but a slight dip and are conveniently disposed for mining. The coal is of the soft bituminous variety, the various seams running in analysis about as follows:

	Per cent.
Volutile matter	25 to 38
Fixed carbon	54 to 71
Ash	3 to 7½
Total sulphur	1.1 to 5.9
Sulphur in ash	0.1 to 0.14

Some analysis of slack from these seams and of the coke made from it are given above in the previous description of the coke plant of the Dominion Iron & Steel Co.

The Pictou coal fields lie about 12 miles inland from Pictou Harbor, and cover an area of about 22 square miles. Geologically considered, the field is of intricate structure, there being frequent faults and the seams having a heavy and constantly changing dip. It is divided into three districts, the Albion, Westville and Vale. At Albion the seams worked are the Main 38 ft. thick, the Deep 22 to 40 ft. thick, the Third 10 to 13 ft. thick, and the McGregor 13 to 20 ft. thick, all occurring in some 500 ft. of strata with over 1,000 ft. of overlying shale. At Westville only one seam, the Acadia, 20 ft. thick, is worked. At Vale the several seams worked are 6 and 8 ft. thick, the thicker seams being the deeper ones. The coal from the Pictou fields is comparatively high in ash, but low in sulphur. It makes good coke. With one exception the seams are gaseous. The Cumberland coal field lies adjacent to Chignecto Bay. Only a portion of the field has been worked on a 6-ft. seam, the total output being about 80,000 tons annually.

General.—The mines of the Dominion Coal Co. are in the Sydney district, where the company owns 160 square miles of coal leases. The leases run for 99 years, the maximum royalty being 12½ cts. per ton to the Nova Scotia government. The aggregate thickness of the workable coal is 30 ft. in known seams. Including both land and water leases the company estimates that 3,000,000,000 tons of workable coal are available. As has been stated already, Mr. Henry M. Whitney, of Boston, Mass., is President of the company. The Canadian offices are at Glace Bay, a few miles from Sydney and about in the center of the mining district. Besides the mining property and plant proper, the company controls the Sydney & Louisburg Ry., extending from Sydney to Louisburg and having 40 miles of main line track. The road is excellently constructed and equipped. The steepest grade against the loaded traffic is 0.8% compensated for curvature and the sharpest curve is 4°. The track is laid with 80-lb. steel rail and is stone ballasted. All bridges are of iron with masonry substructure. The rolling stock consists of 19 locomotives, 50 steel cars of 80,000 lbs. capacity, 350 wooden cars of 15 tons capacity, 300 wooden cars of 10 tons capacity and 50 cars each with two shipping buckets of 5 tons capacity each. The locomotives weigh from 80 to 120 tons.

Shipping Piers.—The shipping piers of the company are located at Sydney and at Louisburg, the two termini of the railway. At Sydney there are two piers known as International Piers No. 1 and No. 2. Pier No. 1 extends 900 ft. beyond and is 27 ft. high above high water mark. It carries two outside tracks for loaded cars and the cars dump direct by chutes to the holds of vessels. When unloaded the cars are switched by means of a radial table to a middle track. Ludlow towers and buckets are also employed for unloading cars. The capacity of the pier is 10,000 tons every 24 hours. Pier No. 2 extends 850 ft. beyond and is 37 ft. 10 ins. high above high water mark. It carries a double track from which the cars unload directly into the vessels by chutes. The empty cars are run by gravity to a drop table at the end of the pier, which works automatically, dropping the cars to a low level track directly below the upper tracks, whence they run by gravity to the assembly yards. The pier is built of South Carolina yellow pine, on creosoted piles, and is protected by creosoted timber cribs at intervals of 100 ft. This pier was built in 1898 and has a capacity of 10,000 tons in 24 hours. The pier at Louisburg is constructed exactly like pier No. 2. A Robins belt conveyor and slack pockets are now being added which it is expected will increase the shipping capacity at least 50%. At Louisburg there is also a low-level pier 1,300 ft. long and 30 ft. wide laid with double track to handle miscellaneous freight.

Reserve Colliery.—At this colliery the "Phalen" seam, 8 ft. thick with a dip of 1 to 12, is mined by the room and pillar method, using partly punching machines and partly hand labor. There are three slopes, viz., French slope 5,000 ft. long, main slope 5,600 ft. long and south slope 1,600 ft. long. The haulage is by endless 1-in. rope operated by 22 × 42-in. engines. The workings are ventilated by a 15-ft. Chandler fan operated by a 16 × 18-in. engine. The bankhead is of wood with shaking and knocking screens and picking belts. Power is supplied by four Babcock & Wilcox boilers, two of 318 HP., and two of 212 HP., and by two ordinary tubular boilers. The monthly output of the colliery is 65,000 gross tons.

International Colliery.—At this colliery the "Harbor" seam, 6 ft. thick with a dip of 1 in 12, is mined by the room and pillar method, using hand picks. Haulage in the mine is done by endless rope 1 in. in diameter operated by an 18 × 36-in. engine. The shaft is 90 ft. deep, 14 ft. long and 6 ft. wide, divided into three compartments. The hoisting is done by two 17 × 42-in. engines, using a 1¼-in. rope. The mine is ventilated by an 8-ft. Murphy fan operated by a 9 × 12-in. engine. The bankheads are of wood with transfer track for mine cars and ordinary

gradient screens. Power is supplied by one 212-HP. and one 318-HP. Babcock & Wilcox boilers and one 7 x 30-ft. Lancashire boiler. The monthly output of the colliery is 25,000 gross tons.

Dominion No. 1 Colliery.—At this colliery the "Phalen" seam, 8 ft. thick with a dip of 1 in 14, is mined by the pillar and room method, using puncher machines driven by compressed air. Hauling in the mine is done by 1-in. rope operated by two 18 x 36-in. engines at a speed of 3 miles per hour. The shaft is 157 ft. deep, 24 ft. long and 10½ ft. wide and is divided into four compartments. The coal is hoisted by two 20 x 54-in. engines, using a 1¼-in. rope. The workings are ventilated by one 12-ft. and one 8-ft. Murphy fans operated by a 11 x 16-in. engine. Air is supplied by three Ingersoll compound Corliss compressors, 22-in. air, 22-in. and 36-in. steam and 42-in. stroke. The bankheads are of steel and are fitted with shaking and knocking screens and picking tables. Power is supplied by five Babcock & Wilcox boilers, three of 212 HP., and two of 318 HP., making a total of 1,700 HP. The boilers are operated by mechanical draft. The output of the colliery is 60,000 gross tons per month.

Dominion No. 2 Colliery.—At the time of the visit work was in progress sinking the shafts for this new colliery. The coal shaft as planned will be 37 x 11 ft. for 400 ft. to the "Harbor" seam, and thence 21 x 11 ft. for 500 ft. further to the "Phalen" seam. The air, pumping and main shaft will be 34 x 11 ft., 900 ft. deep to the "Phalen" seam. The coal shaft will have two compartments for each seam and be capable of a total output of 6,000 gross tons per day. Hauling in the mines will be done by electric motors. The bankheads will be of steel 125 ft. high. The machinery now being built will consist of four 318-HP. Babcock & Wilcox boilers, two 34 x 48-in. hoisting engines, one fan and two single engines, fan 12 ft. diameter, engines 20 x 42 ins.; two duplex compound compressors, high pressure steam 31 ins., air 32 ins., low pressure steam 57 ins., air 51 ins., stroke 60 ins. On the day of the visit the coal shaft struck the "Harbor" seam at a depth of 400 ft.

Dominion No. 3 Colliery.—At this colliery the "Phalen" seam, 8 ft. thick with a dip of 1 in 14, is mined by the room and pillar method, using puncher machines driven by compressed air. The coal is hauled overground to Dominion No. 4 Colliery bankhead, a distance of one mile. Hauling in the mine is done by a 24 x 54-in. engine, operating a 1-in. wire rope. The workings are ventilated by a 6 ft. Murphy fan. The compressor plant consists of one Rand 18 x 20 x 30-in. compressor, and a duplex compound compressor built by Wigan in England of the following dimensions: low pressure steam, 51 ins., air 51 ins.; high pressure steam 31 ins., and 32 ins.; stroke 60 ins.

Dominion No. 4 Colliery.—At this colliery the "Emery" seam, 5 ft. thick with a dip of 1 in 10, is mined by the room and pillar method, using puncher machines. The hauling in the mine is done by endless 1-in. rope, operated by a 24 x 54-in. engine. Steam is supplied by two Babcock & Wilcox boilers, aggregating 624 HP., operated by mechanical draft. The workings are ventilated by an 8-ft. champion fan. The compressor plant consists of two small 18 x 20 x 30-in. Rand machines. The bankheads are of wood, and contain knocking screens, air tipples and picking belts, operated by a rope drive from an 18 x 36-in. engine.

Caledonia Colliery.—At this colliery the "Phalen" seam, 8 ft. thick with a dip of 1 in 14, is worked by the room and pillar method, partly by hand and partly by puncher type of coal cutting machines. The hauling in the mine is done by 1-in. endless wire rope, driven by a 23 x 42-in. engine, there being about 12 miles of rope on the engine. Hoisting is done by a 1¼-in. rope, operated by 20 x 48-in. engines, the draft being 182 ft. deep, 17 ft. long and 11 ft. wide, divided into three compartments. The compressed air is supplied by a Rand compound compressor with 22 x 48 x 60-in. steam and air ends. Ventilation is afforded by one 12-ft. Murphy and one 15-ft. Dixon fans. The bankhead is of steel and has shaking and knocking screens and picking table. Power is supplied by five 212-HP. Babcock & Wilcox boilers. The monthly output of the colliery is 58,000 gross tons.

Coal Washing Plant.—The coal washing plant consists of two Robinson-Ramsey coal washers, with a combined capacity of 2,000 tons of washed coal per day, one built in 1897 and the other in 1900. The slack coal is brought from the mine in cars and dumped into bins under the track, having a storage capacity of 1,200 tons, and from which it is drawn by two cable conveyors to the center of the bins. From here it is elevated to the top of the washhouse and divided between the two washers. An average of 41% of the contained ash and 28% of the sulphur is removed by the washing. Coming from the washers the coal is carried over screens and the water drained into sludge tanks, from which it is pumped by four pulsometers of 1,000 gallons capacity per minute, and is used over and over again. After passing over the screens the coal falls into another elevator, which takes it to the washed coal storage bin, holding 1,800 tons, and from here it is trapped back into the cars. Power is furnished by four 5 x 14-ft. return tubular boilers, and the water is piped from a lake 3,000 ft. from the plant.

In describing the company's mines and their equipment, considerable attention has been given to minor details which ordinarily call for little consideration. The purpose of this has been to show somewhat exactly the physical condition in which these properties are at present to produce coal in competition with the coal mines of the United States.

Old Louisburg.

At the conclusion of the trip to the collieries the visitors were taken by one of the company's tugboats to old Louisburg, where a couple of hours were spent most enjoyably in loitering around the ruins and in recalling such scraps of history as were yet remembered concerning the checkered career of this famous old French fortress. A monument erected by the Society of the Colonial Wars, one or two fishermen's houses, and flattened heaps of masonry, with here and there a few remaining arches of old bombproofs rising out of the grass-grown earthworks, are all that remain to recall the strongly fortified settlement of 3,000 people which was twice wrested from France in her disastrous colonial wars with England in North America.

Bras d'Or Lakes.

On the morning of Aug. 23 the visitors took leave of their Sydney hosts, who had arranged that the first part of the return trip should be by steamer through the beautiful Bras d'Or lakes as far as Grand Narrows, where the train would be waiting to take the party the next stage of its trip to New Glasgow. The day was a beautifully clear one, with a bracing atmosphere which called for overcoats and wraps, and a sun which touched the water and the bordering hilltops with a color that made it easy to understand why the old Breton fishermen had called this inland sea the Arm of Gold. It was Nova Scotia scenery. Lake George, the highlands of the Hudson, Lake Seneca and the rocky shores of Lake Superior were called up by one and another in illustration, but it was none of these, and yet something of each. Certainly no more beautiful gateway could have been selected by our Sydney hosts by which to speed our parting from their hospitable city. The boat arrived at Grand Narrows in the afternoon, where the party resumed its special train, which arrived in New Glasgow during the night.

New Glasgow.

At New Glasgow the party was met by members of the local committee, headed by Mr. Graham Fraser, Vice-President of the Nova Scotia Steel Co., and Mr. Charles Fergie, Manager of the Intercolonial Coal Co. In good Scotch fashion, the hospitalities began early. At 9 o'clock a special train took a portion of the party to the collieries of the Intercolonial Coal Co., at Westville, where an inspection of the mines was made and luncheon taken at the beautiful home of Mr. Fergie. The Intercolonial is one of the principal mines of the Pictou coal district, and is well equipped with compressed air underground haulage and pumping, and modern colliery appliances and machinery. For the portion of the party which did not visit the mines, a carriage ride around the city of New Glasgow and to the top of Fraser Mountain was provided. At 12 o'clock noon the Institute's special train was again boarded for a trip to the works of the Nova Scotia Steel Co., and Pictou, where an excursion was arranged for around Pictou Island and skirting the coasts of Prince Edward Island and the mainland.

Nova Scotia Steel Co.

The works of the Nova Scotia Steel Co. are of particular interest, as being the only steel works of much importance operating in Nova Scotia on Newfoundland ores from Bell Island. The blast furnace is located at Ferrona and is connected with the steamer line from Bell Island landing, at Pictou Point, with the limestone quarries, and with the Intercolonial Ry. by the company's own railway, 13 miles long. The furnace is 65 ft. high, 15 ft. diameter at bosh and 9½ ft. diameter at the crucible. It has eight tuyeres and two cinder notches; there are two down carriers, one carrying gas to the hot blast stoves and the other leading to the boilers. There are three hot blast stoves of the three-press Massick & Crooke type, each stove being 16½ ft. in diameter inside the shell and 60 ft. high. The two blowing engines have 36-in. steam cylinders, 84-in. air cylinders and 4-ft. stroke. Steam is generated by a battery of eight tubular boilers set in pairs, working at 100 lbs. pressure. The boilers are 6 x 20 ft., with 52 4½-in. tubes. The fuel used is waste gas from the furnace, the draft being produced by a steel chimney 7½ x 125 ft. The water is pumped to a 10 x 80-ft. standpipe, from which it is delivered. The engine house is of brick, 35 x 60 ft., the casting house is of steel, 50 x 153 ft., and there are ore sheds, hoists, scales, etc.

Coal Washing Plant.—The coal for coking has to be washed, and in 1892 the company erected a coal washing plant, which was the first ever erected in Canada. At this plant the coal is elevated and screened and the large coal crushed, the resulting fine coal being separated into three sizes, as follows: 0 to ⅛-in., ⅛ to ¼-in., and ¼ to ⅜-in. The coal is washed in two-compartment feldspar jigs arranged with variable stroke. The washed coal is removed by elevation to a storage tower, and the refuse is taken to the dumps. The water used is raised by a centrifugal pump, and after performing its round of work returns again to the pump. The entire plant works automatically. The coal washed contains from 17 to 35% of ash and 2½% of sulphur, and the washed coal contains on an average 10% of ash and 1.35% of sulphur. The total capacity of the plant is 300 tons of washed coal per 10 hours. The average cost of washing, winter and summer, is ¼ cts. per ton.

Coking Plant.—The coking plant is located close to the coal washing plant, and comprises 54 retort coke ovens of the Bernard or improved Copee type, and of the following dimensions: Length, 33 ft.; height, 6½ ft., under roof; medium width, 23½ ins. Each oven is charged with about 7 tons of washed coal, all below ⅜-in., every 48 hours; the coal yields 73% or 74% coke. The total output of the 54 ovens is from 115 to 120 tons of coke per 24 hours, all of which is used in the company's blast furnace.

Ore Deposits.—Besides the ore from its Bell Island mine, the company uses brown and red hematite ores from its mines along the East River, which are connected with the furnace by the short railway line previously mentioned. The output of these mines is about 4,000 tons per month. The ore contains considerable clay, which has to be removed by washing. The washer used is a conical revolving drum with inclined interior blades or pins, which work the ore from the large to the small end. The water enters this drum at the small end, washing the clay from the ore, which it meets in its descent, and discharging it by spouts which lead to a settling pond. The ore is discharged from the small end of the drum into a bin, and from thence into cars.

Steel Works.—The company's steel plant is located at New Glasgow and is connected by its railway with the furnaces, coking plant, etc., previously described. The plant comprises two 20-ton and one 35-ton Siemens furnaces, which are served by one Chaplin three-cylinder 50-ton steam crane having a clear span of 50 ft. There are three gas and five reverberatory heating furnaces. The mill contains a 26-in. cogging mill, with train of five roughing and hydraulic ingot manipulators; heavy vertical billet shears with five rolls; one 20-in. plate mill; one 16-in. and one 12-in. bar mills; one 9-in. guide mill. The forge shop contains one 5-ton and several smaller steam hammers and a 15-ton crane. The machine shop contains, besides smaller tools, a 30-in. slotter; a 9-ft. radial drill, with 5-in. spindles and five smaller drills; and nine lathes, one of which will take 50 ins. over the carriage, 8 x 10 ft. in the gap and 37 ft. between centers. The output of the plant is 150 tons of steel ingots per day, which are worked up into forgings, plates, bars and merchant steel.

New Glasgow and "New Scotland."

The fine weather of the previous day's sail down the Bras d'Or had continued with the Institute's party, and when the trim little steamer drew up to the steel company's wharf to treat the excursionists to another glimpse of Nova Scotia's island and coast scenery there were few too tired or indifferent to hasten aboard. Here our hosts were "at home" with their wives and daughters with them, and certainly no more courteous and gracious hospitality of the kind that comes from joy in the guest and his pleasure was ever extended to a friend than by these Scotch men and women to their visitors of a day. It was a "gathering of the clans," as one of the members remarked, and indeed the names which were heard when introductions could be made and acquaintance begun—Fraser, Graham, Campbell, Douglas, MacDonald, Mackenzie, MacIntosh; covenanter and king's man—made the statement seem more a truth than a joke; and when on the homeward sail our hosts—men and women—gathered on the after-deck and sang one after another the ballads of old Scotland, with the sun shining astant on the waters and turning the abrupt headlands into masses of blue shadow, it needed no more to show that Nova Scotia, in this little community, at least, was in verity a "New Scotland."

Halifax.

The Institute's special train arrived in Halifax on the morning of Aug. 25, where the program called for a stay of four days. On Monday, Aug. 27, a short meeting of the members was held at the Halifax Hotel, at which Mr. R. W. Raymond, the Secretary of the Institute, read by title a list of some 25 papers which have been accepted for publication in the Institute's Proceedings. Mayor G. W. Stuart, of Truro, also read a short paper describing the gold mines of Nova Scotia and the methods of working them. This paper was briefly discussed by Dr. E. Gilpin, Inspector of Mines for Nova Scotia. Secretary Raymond then announced that the next meeting of the Institute would be held in Richmond, Va., in February, 1901, and that the following meeting would probably be held during the following October in the City of Mexico, in connection with a special excursion trip through that country.

On Tuesday, Aug. 28, the party visited the gold mines at Waverly, near Halifax, where a modern 60-stamp mill has recently been erected to handle the low grade quartz ores of that vicinity. Luncheon was served at the mines. The remaining period of the stay at Halifax was spent in excursions around the city and harbor, visiting the British warships, the public gardens, the garrison church and other places of interest. On Wednesday, Aug. 29, the party started on its return trip to Quebec, where it arrived, with the exception of about 25 members, who disembarked at Truro for an excursion through Newfoundland, on the morning of the 30th. At Quebec the party disbanded as an excursion party, the members departing for home by various routes during the day. Those of the original New York party who returned directly home arrived in New York city on Aug. 31.

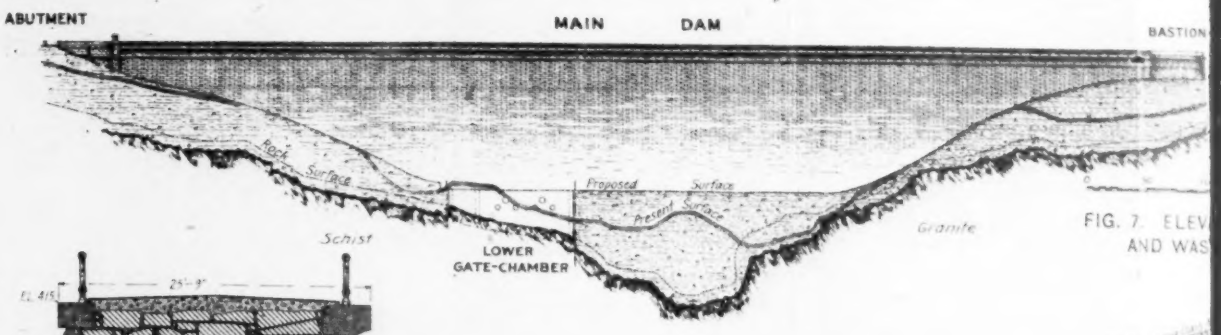

FIG. 7. ELEV
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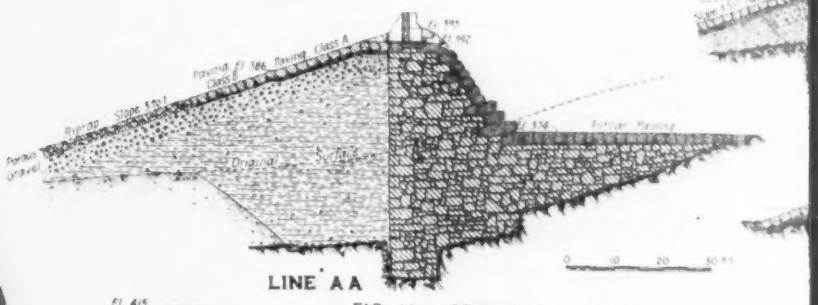


FIG. 11a. SECTIONS THROUGH WASTE WEIR.

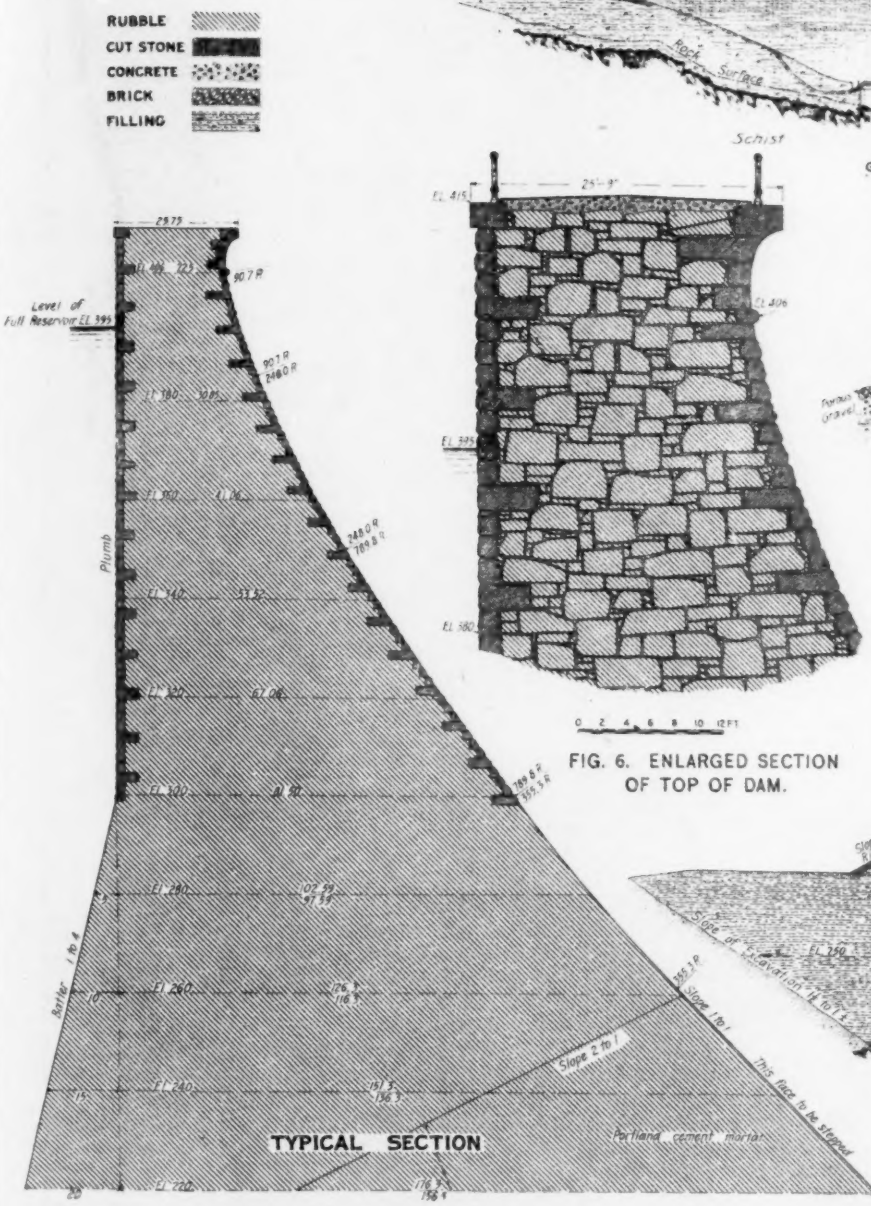


FIG. 4. TYPICAL SECTION.

FIG. 6. ENLARGED SECTION OF TOP OF DAM.

FIG. 13. SECTION OF DRAIN AT TOE OF DAM

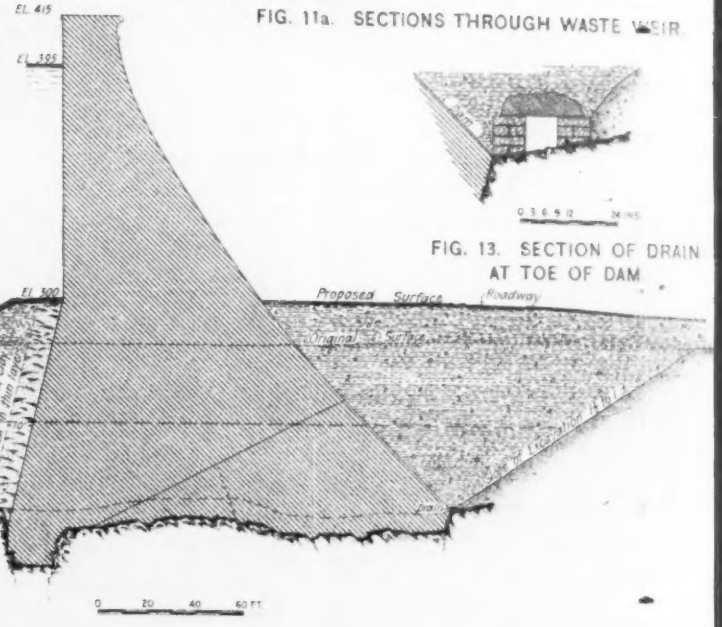


FIG. 5. SECTION AT DEEPEST PART OF VALLEY.

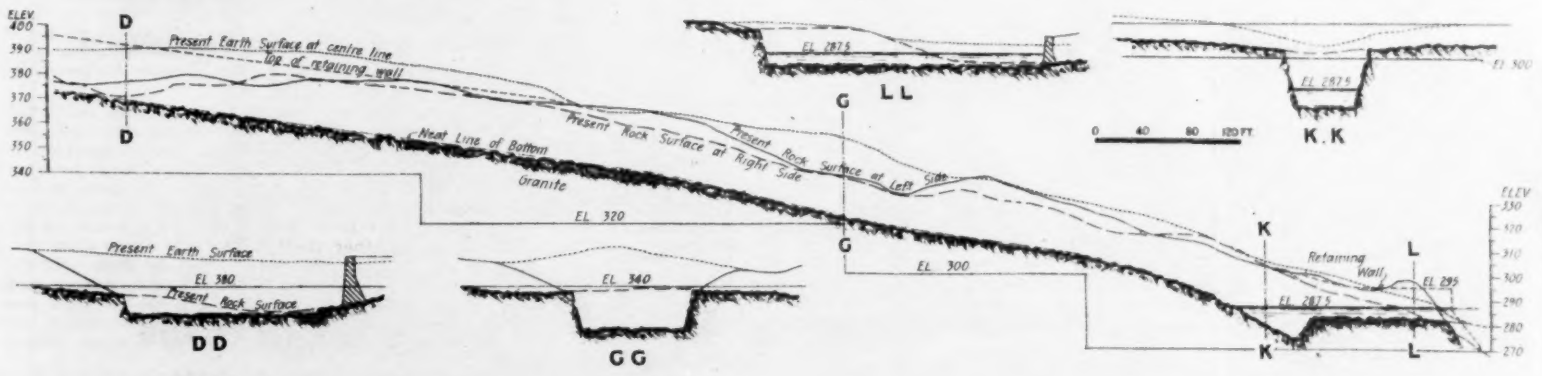


FIG. 12. PROFILE AND SECTIONS OF WASTE CHANNEL.

THE WACHUSETT DAM. METROPOLITAN
Frederic P. Stearns, M. Am. Soc. C

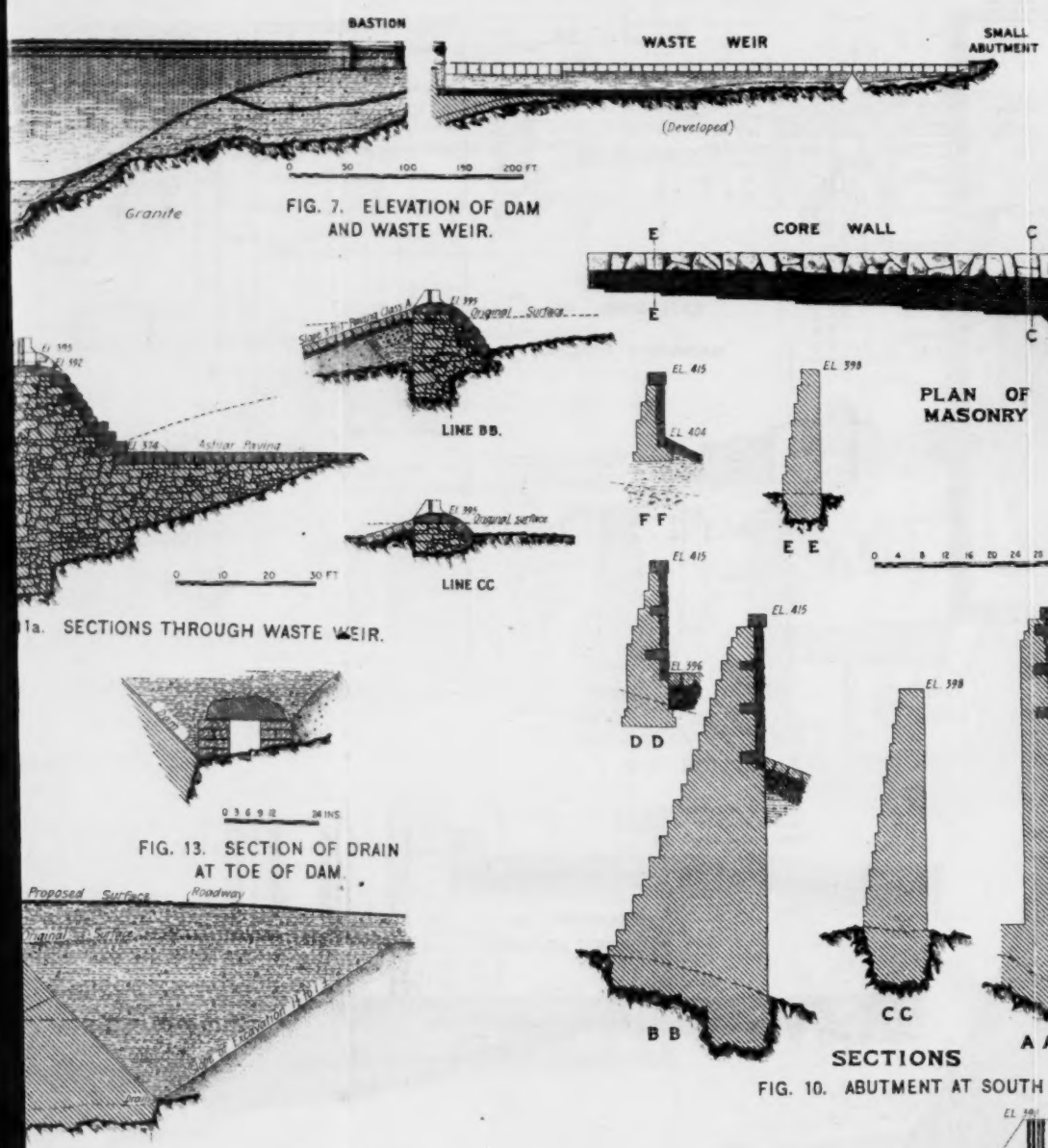
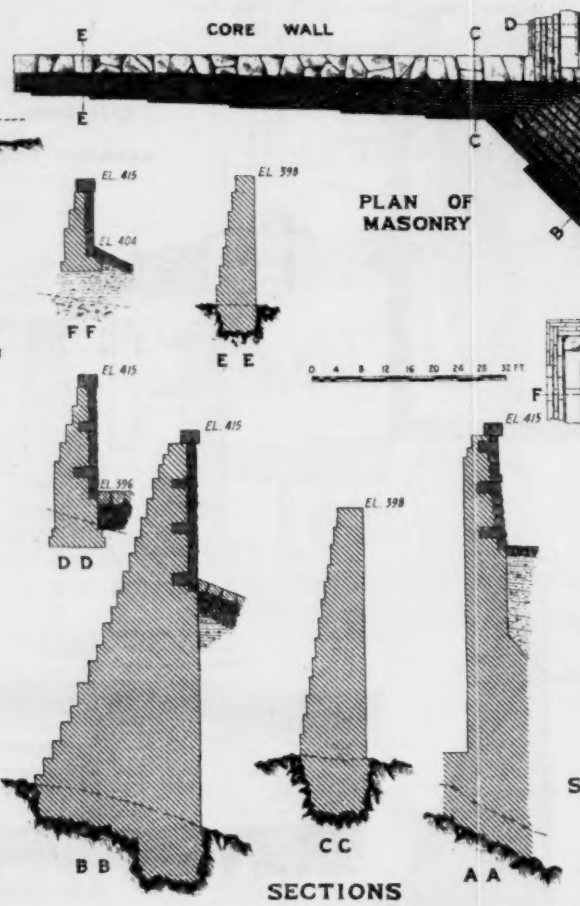
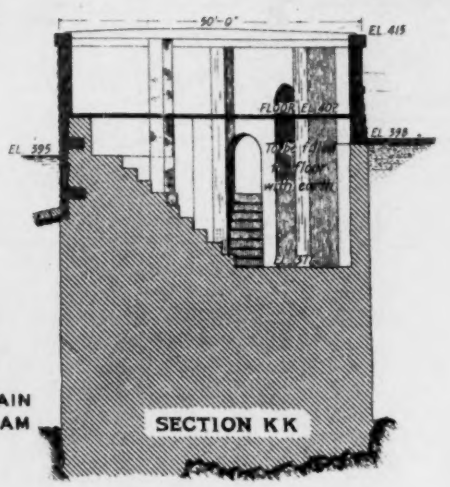


FIG. 7. ELEVATION OF DAM AND WASTE WEIR.

1a. SECTIONS THROUGH WASTE WEIR.

FIG. 13. SECTION OF DRAIN AT TOE OF DAM.





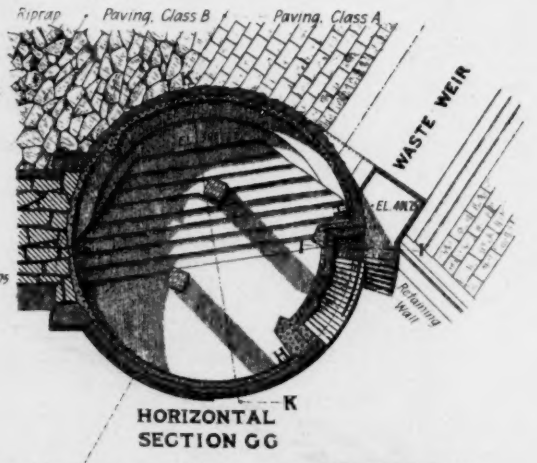
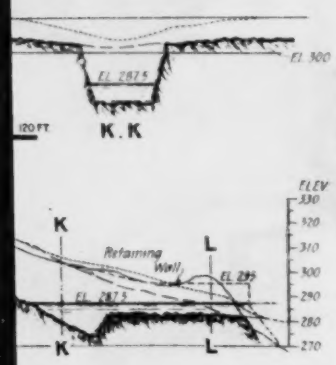


FIG. 9. BASTION AT NORTH END OF DAM.

FIG. 10. ABUTMENT AT SOUTH END OF DAM.

ST PART OF VALLEY.



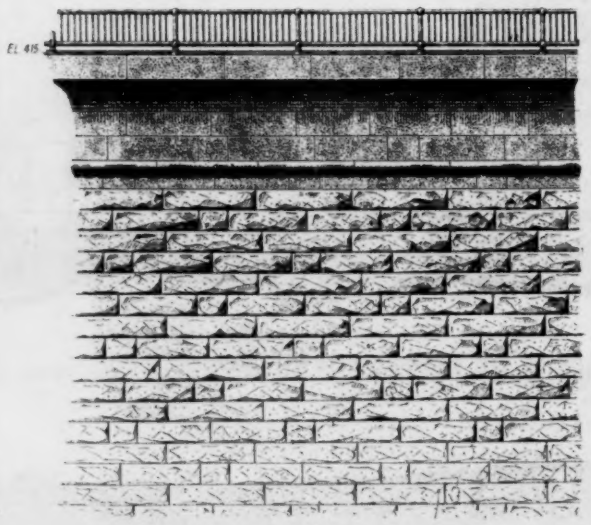
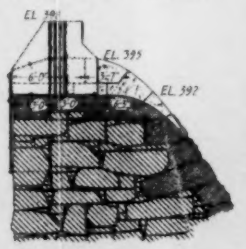
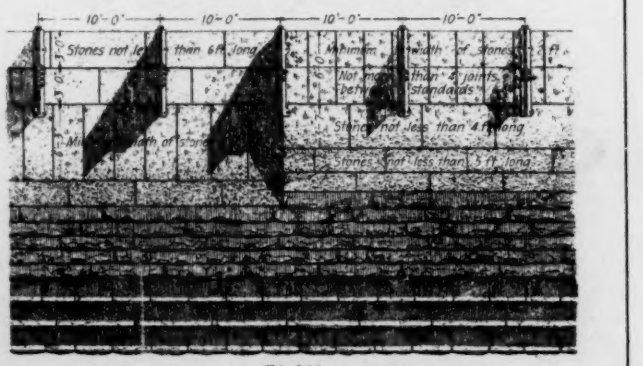
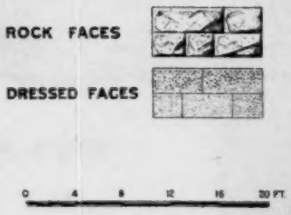


FIG. 8 ELEVATION SHOWING FINISH OF FRONT OF DAM AT COPING.







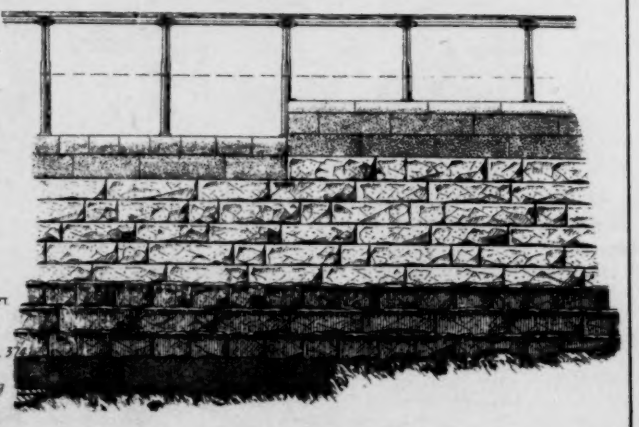
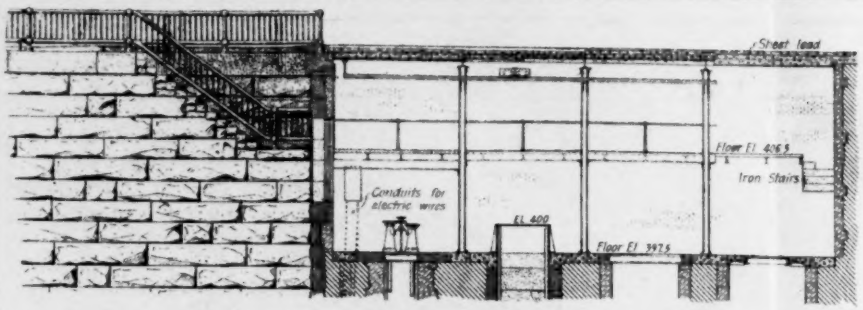


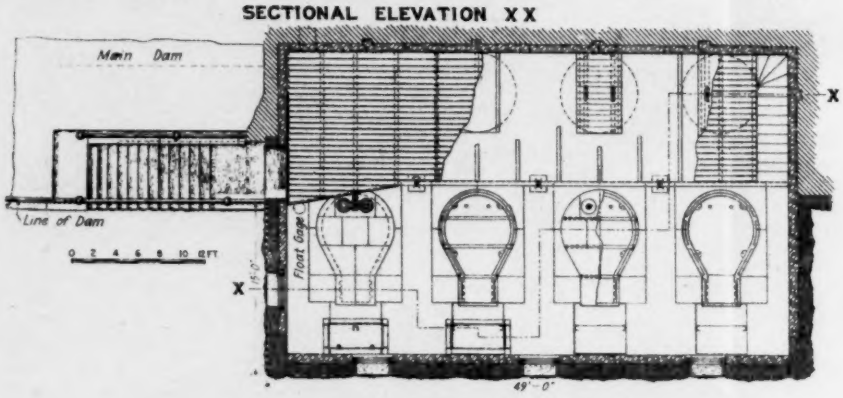
FIG. 11. WASTE WEIR.

USETT DAM. METROPOLITAN WATER SUPPLY, BOSTON.
ederic P. Stearns, M. Am. Soc. C. E., Chief Engineer.

CHAS. HART, LITH., 38 VESEY ST., N. Y.



SECTIONAL ELEVATION XX



SECTIONAL PLAN

FIG. 16. DETAILS OF UPPER GATE CHAMBER.

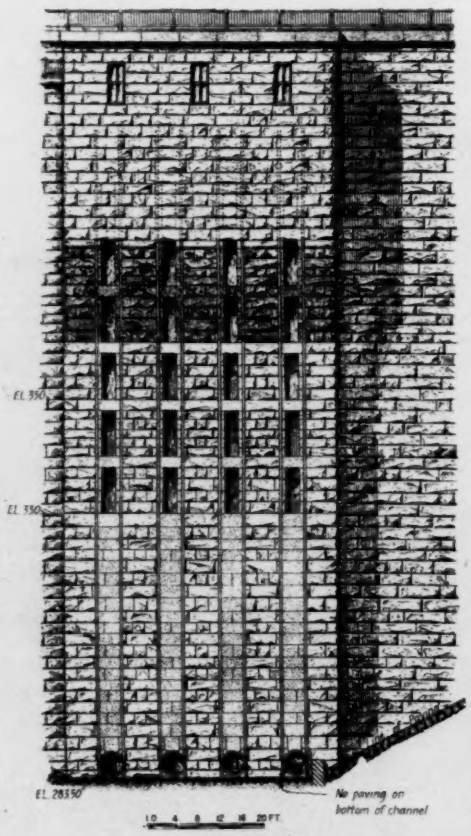


FIG. 15. ELEVATION OF UPPER GATE CHAMBER.

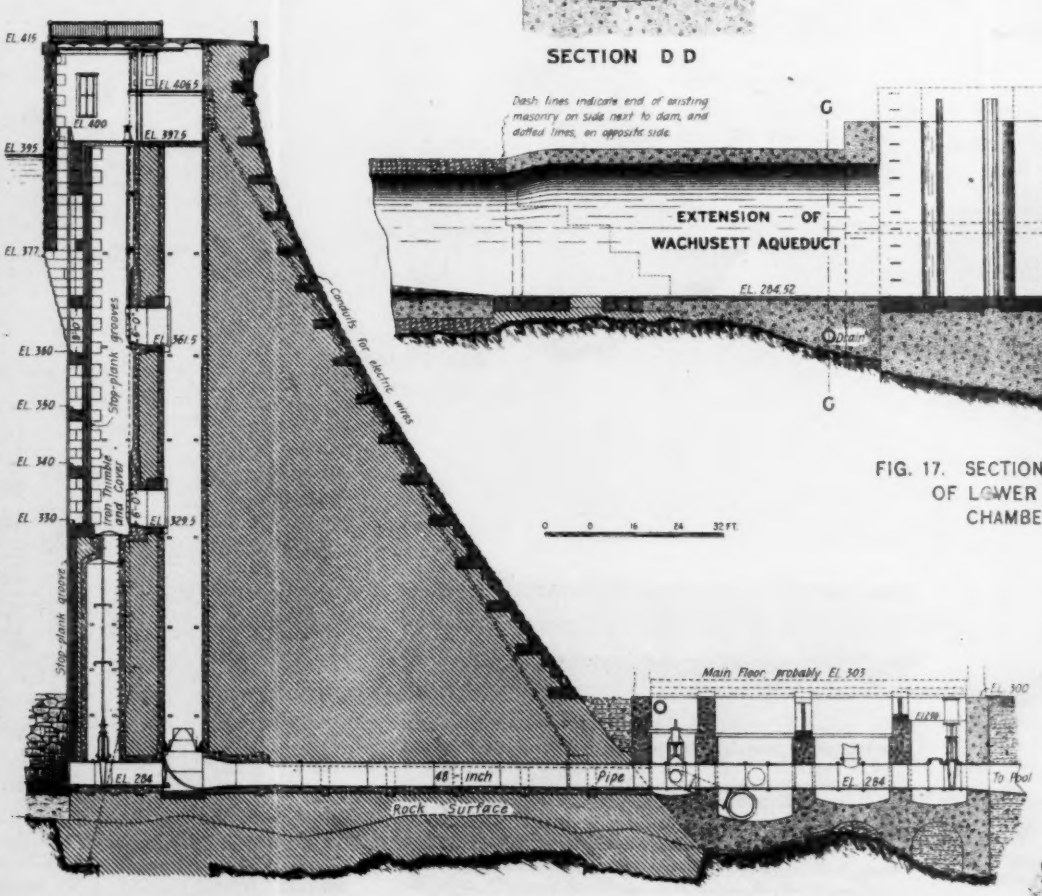


FIG. 14. SECTION OF DAM SHOWING GATE CHAMBERS.

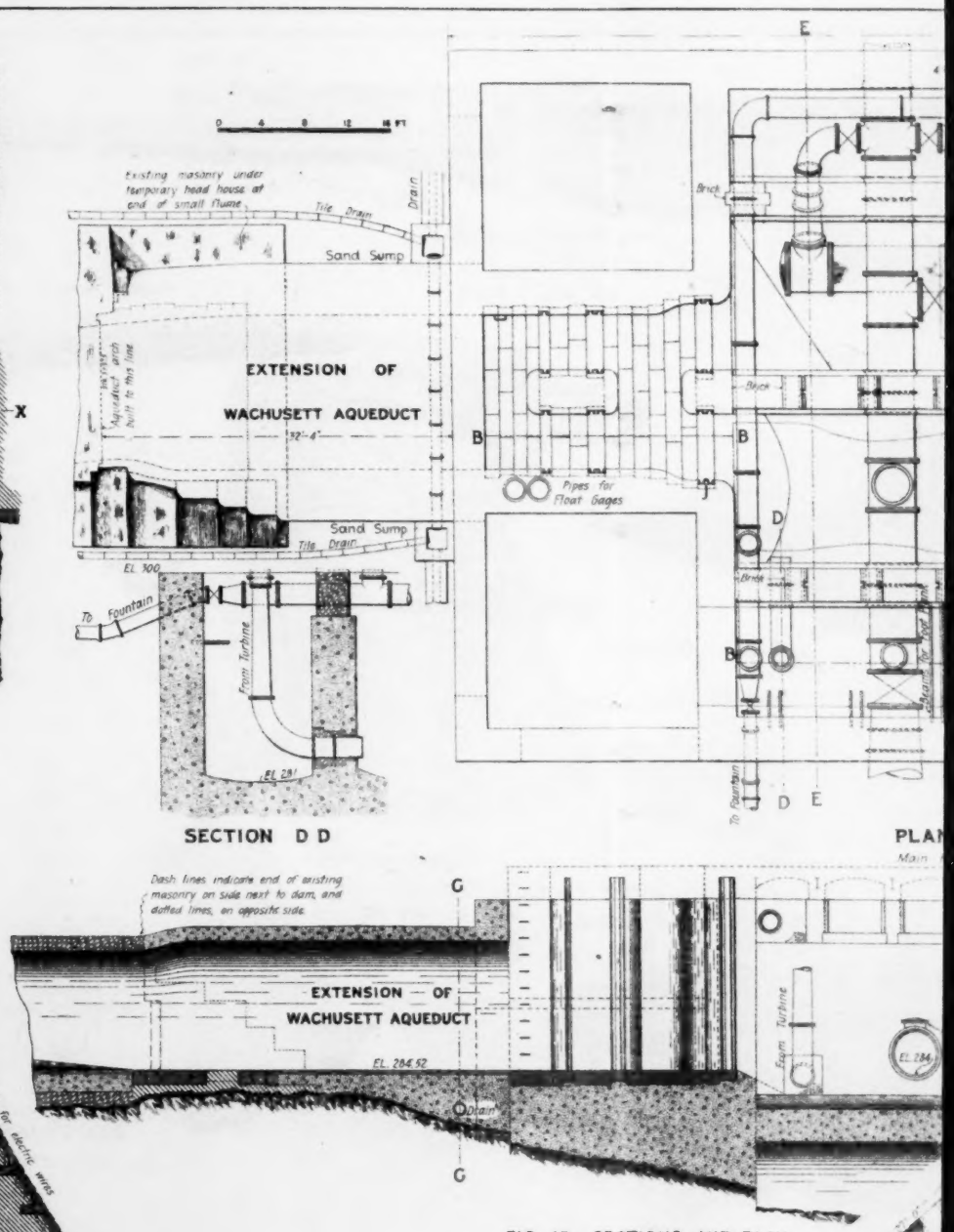
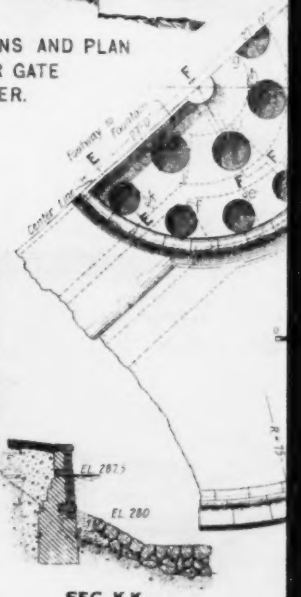
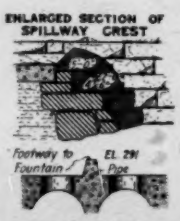


FIG. 17. SECTIONS AND PLAN OF LOWER GATE CHAMBER.



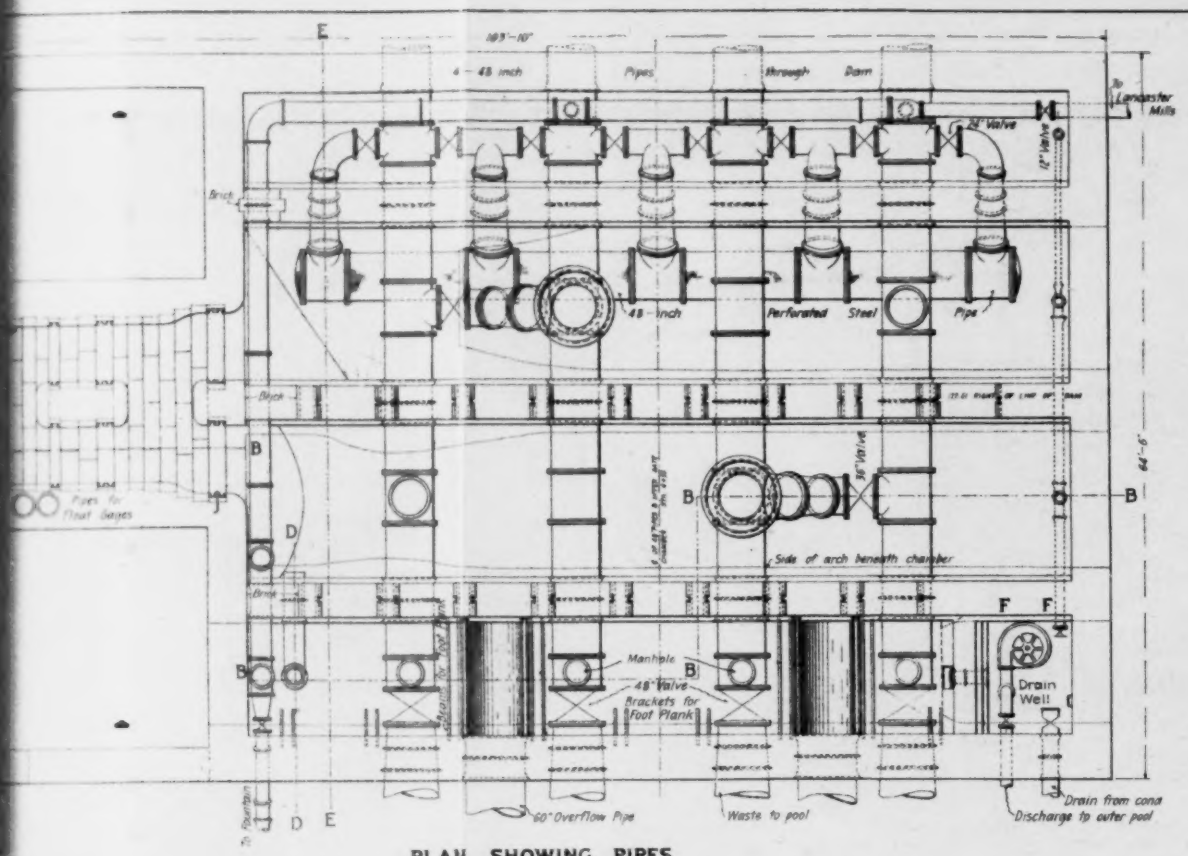
SEC. K K



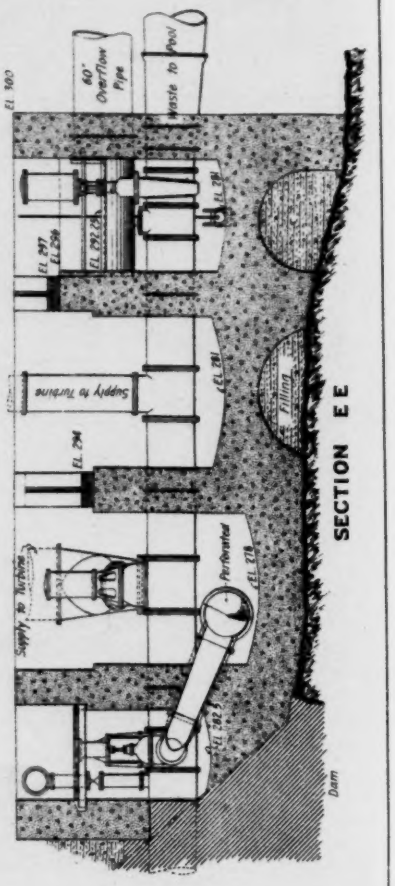
SECTION E E

SECTION PERPENDICULAR TO LINE OF DAM ON CENTER LINE OF POOL

FIG. 18. OVERFLOW POOL AND CONNECTIONS.



PLAN SHOWING PIPES



SECTION E E

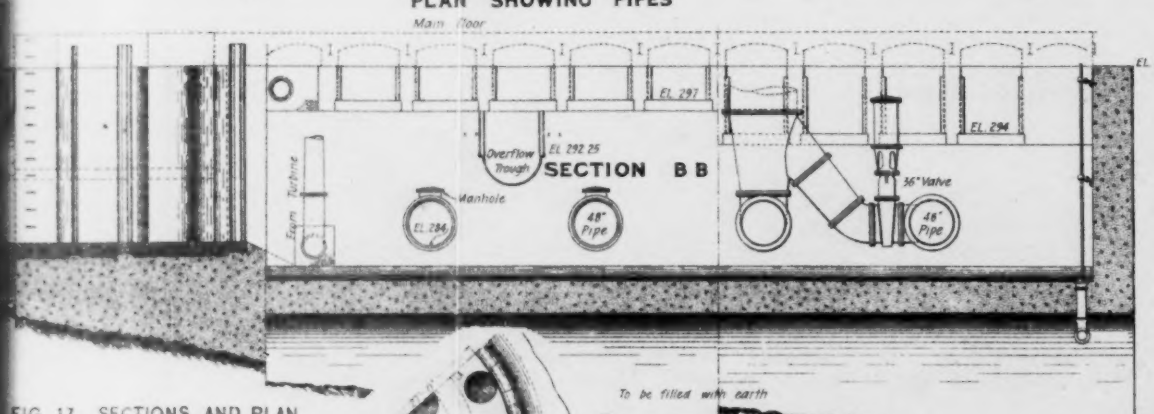
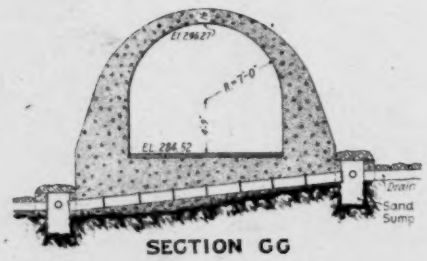
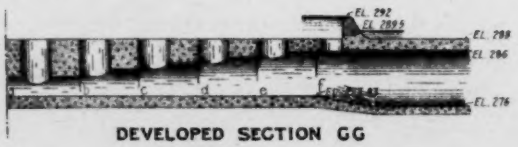


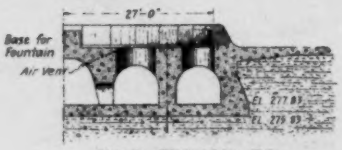
FIG. 17 SECTIONS AND PLAN OF LOWER GATE CHAMBER.



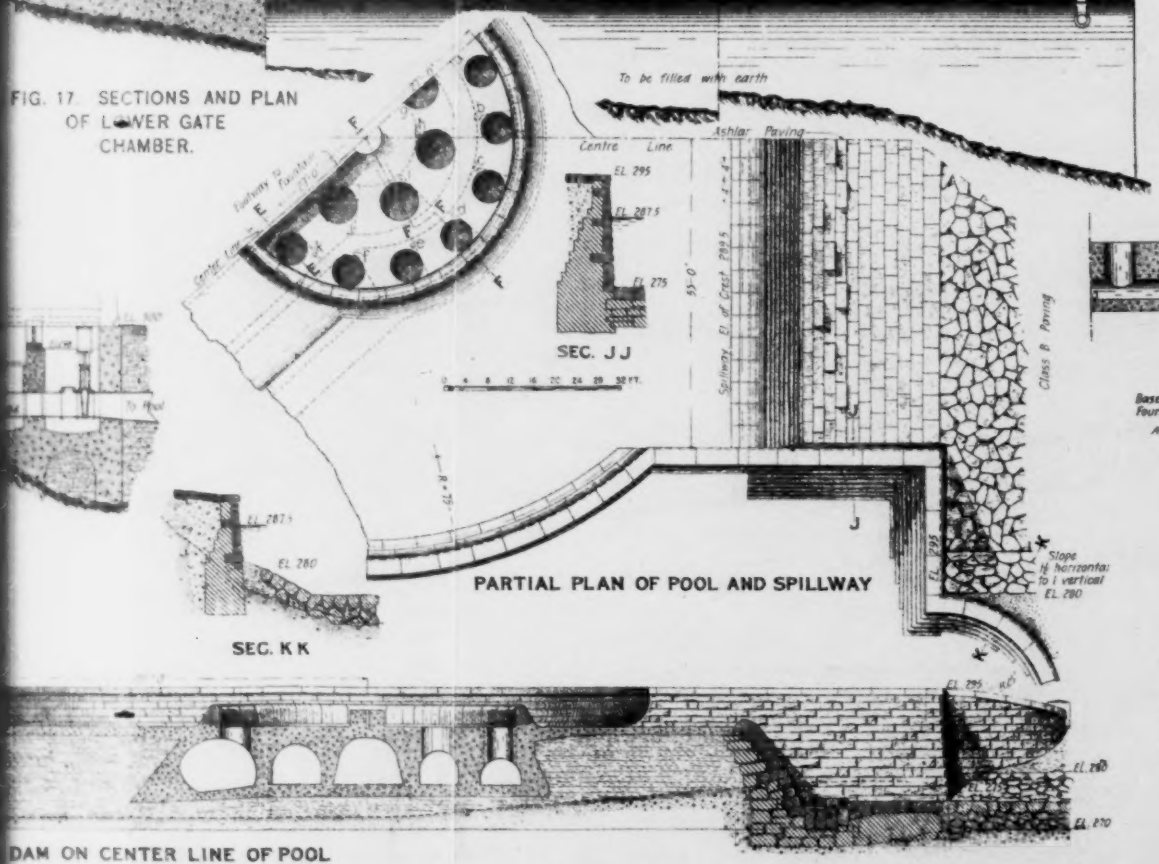
SECTION GG



DEVELOPED SECTION GG



HALF SECTION F F



DAM ON CENTER LINE OF POOL
ND CONNECTIONS.

GATE CHAMBERS FOR
WACHUSETT DAM.
METROPOLITAN WATER
SUPPLY, BOSTON.

Frederic P. Stearns,
M. Am. Soc. C. E.,
Chief Engineer.

CHAS. HART, LITH., 39 VESEY ST., N. Y.